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MEMOIRS

OF THE

AMERICAN ACADEMY

OF

ARTS AND SCIENCES.

VOL. II.—PART I.

PRINTED AT *BOSTON*,
BY ISAIAH THOMAS AND EBENEZER T. ANDREWS,
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MDCCXCIII.

Mo. Bot. Garden,
1897.

ADVERTISEMENT.

TO accommodate the purchaser; and to invite communications, the Academy has thought it expedient to publish its Memoirs in the present form. In the choice of papers, the Committee, to whom the selection was entrusted, have studied utility, variety, and entertainment. As communications increase, new publications will appear. And it is to be hoped, that a regular series of numbers will call the attention to philosophical inquiries; and shew, that the Academy does not overlook the end of its institution. The reader will remember, that the Society is not responsible for any communications, which may be selected and published. They must stand or fall by their own merit. The mathematician must answer for his own reasonings, the philosopher for his experiments, and the theorist for his conjectures.

Cambridge, November, 1859.

It was voted by the Academy at the last Annual Meeting, that Part I. of Volume II. be reprinted, in order to make good complete sets of the First Series of Memoirs.

JOSEPH LOVERING,	*Committee*
C. C. FELTON,	*of*
JEFFRIES WYMAN,	*Publication.*

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ALLEN AND FARNHAM, PRINTERS.

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ERRATA.

Page 21, line 8, from bottom, for *Annulus*, read *Annular*.—Page 70, bottom line, for *Obsessor*, read *Obsessos*.—Page 87, line 1st, for *heated*, read *treated*.—Page 88, 10th column, against Mons, read 13, 7.

Mr. LOWELL's

EULOGY,

ON

The Hon. JAMES BOWDOIN, Esq. L. L. D.

AN

E U L O G Y,

ON

The Honourable JAMES BOWDOIN, Esq. L. L. D.

LATE PRESIDENT OF THE

AMERICAN ACADEMY of ARTS and SCIENCES.

Who died at *BOSTON*, NOVEMBER 6, A.D. 1790.

Delivered before the SOCIETY, *January* 26, 1791,

BY J O H N L O W E L L,

One of the COUNSELLORS of the ACADEMY.

PRINTED at *BOSTON*,

By ISAIAH THOMAS and EBENEZER T. ANDREWS,

At FAUST'S STATUE, No. 45, *Newbury Street*.

MDCCXCI.

At a Meeting of the AMERICAN ACADEMY *of* ARTS *and* SCIENCES,
January 26, 1791.

VOTED,

THAT Dr. CHARLES JARVIS, the Rev. JEREMY BELKNAP, and EBENEZER STORER, Esq. be a Committee to return the thanks of the ACADEMY to the Hon. JOHN LOWELL, Esq. for his EULOGY on their late PRESIDENT, and to request a copy of the same for the press.

ATTEST, SAMUEL WEBBER,
Recording Secretary.

MR. *LOWELL's*

E U L O G Y,

ON

The Hon. *JAMES BOWDOIN*, Esquire.

Late PRESIDENT of the AMERICAN ACADEMY of ARTS and SCIENCES.

Who died at *BOSTON*, NOVEMBER 6th, A. D. 1790.

MR. VICE PRESIDENT, AND
GENTLEMEN OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES,

TO suspend for a while, the ordinary pursuits of life, whether of an active or contemplative nature—to trace the path of the great, the virtuous, and the wise, through all their exertions for the benefit of mankind—and to portray their characters as an example to the world—has been the practice of all ages—and is certainly a rational, an useful, and a philosophic employment. Such a task, your too partial sentiments have assigned me this day.

WE cannot but recollect, that once before we have been assembled in this august place—when, from this desk, our respected and beloved President, in strains of wisdom, urged us to the honorable employment of contributing to the advantage of our country, by useful studies, and important literary researches. We heard him with attention: We venerated him as our Patron: We respected him as a Philosopher and a Man. But he is now no more! and it is in obedience to your commands, that I have this day undertaken, from the same place, the pleasing though melancholy task of pronouncing his Eulogy.

IT may be pertinent on this occasion to observe, that it has been usual for such societies, in other countries, on the death of those members who have been distinguished for their talents and their virtues, to direct some of their fellows to delineate their characters; not in the strains of undeserved panegyric, nor in the form of tumid declamation, but in the plainer garb of truth: Such, I understand to be your expectations from me on this occasion. I am not therefore at liberty to exercise the talents of an orator, if I possess them, but am restrained by the more rigid academic rules. Let me then rest on your candor, while I attempt a sketch of the life of Mr. BOWDOIN, and of those incidents, which reflect honor on his memory.

THE ancestors of our President were inhabitants of *Rochelle*, in France: They were of honorable descent, and possessed a fair inheritance there, and were of that body of Protestants, who for a long time resisted the attempts of the tyrants of that country to enslave them, and to compel them against their consciences to

abandon

abandon their religion. His father, in the year 1686, on the persecution which followed the revocation of the edict of *Nantz*, left his native country, and facing poverty and danger, fled to America, as the asylum of liberty, and in the year 1688, settled in the town of *Boston*: By his industry, economy and integrity, he accumulated a very ample fortune; and possessed so much of the esteem and respect of his fellow citizens, that he was chosen a member of the Council, for several years before his death.

OUR President was born at *Boston*, August 7th, 1726, and having made the usual progress in scholastic and collegiate studies, was admitted to his degree of Bachelor of Arts, at *Harvard College*, A. D. 1745, and of Master of Arts, A. D. 1748. During this period he was distinguished by the decency of his behaviour, the complacency of his manners, the regularity of his conduct, and by his solicitude to acquire useful knowledge, which excited him to industry and attention, and laid the foundation for that respect, which he long maintained in the literary world. It does not appear, that he possessed that extraordinary brilliancy of genius, which entitled him to be ranked amongst those who have astonished the world by the force of their imaginations, or the uncommon power of their natural abilities: Indeed such characters are rarely to be found, and when they exist, are usually deficient in that solidity of judgment which is necessary to restrain the extravagance of their ideas, and their romantic and impious principles, and eccentric conduct, often conduce more to the injury of the world, than the brightness of their conceptions to its benefit. Our deceased friend possessed the more useful talents of

sound

sound good sense, and clearness of discernment, which, with an improved mind, cultivated with assiduity, and enriched by learning, enabled him in all circumstances of life to decide with propriety.

HE had scarcely attained to the age of twenty one years, when by the death of his father, he found himself in possession of a great estate: This event was a trial of his virtue; for however anxiously most men labour to accumulate riches for their children, it is a truth, founded on the principles of reason, and confirmed by observation, that they commit to their hands a dangerous cup, with which they are more frequently intoxicated and debauched, than rendered happy or useful to the world: But Mr. BOWDOIN had already acquired too fixed a character, to be drawn aside from his rational pursuits, or diverted into the paths of dissipation: He received the bounty of providence with moderation, and used its gifts without abusing them: This accession of property, placing him in easy and independent circumstances, he formed an early connection with a respectable family, which happily continued during his life, and afforded him that solace and domestic enjoyment, which can alone give a zest to the researches of the studious, and render pleasing the toilsome enterprizes of the laborious. In his juvenile days he indulged himself in sporting in the fields of *Parnassus*; but he never suffered his muse to lead him astray from the paths of decency and virtue. These lighter performances were directed to make the heart better, and to exhibit to his young friends, morality and religion in a pleasing garb. He gave one of them to the world, under the title of "*A Paraphrase of the Economy of*

Human

Human Life." But his genius and taste led him more frequently to fix his attention on the closer studies of natural and moral philosophy, ethics, politics, and general jurisprudence.

IN the year 1753, at the age of twenty-seven, he was chosen a representative for the town of *Boston*. The uncommon maturity of his judgment, was evidenced by this choice, as few persons have been introduced into the legislature, from the *capital*, at so early an age.

ABOUT this time he formed and fixed his friendship with those persons in this and the neighbouring governments, who for their classic taste, liberal sentiments, attachment to literature and the cause of freedom, were eminently distinguished: A FRANKLIN, a WINTHROP, a PRATT, an OTIS, a COOPER, a MAYHEW, and a THACHER, were in this number, besides other characters not less deserving, who still survive. Many letters on literary subjects, and some of them on deep philosophical questions, passed between him and the great American philosopher lately deceased, which shew the real talents of both in those sciences, and the esteem and respect which they entertained for each other.

IN the year 1757, he was elected a member of the Council, and continued to be annually chosen until the year 1769, when the choice was negatived by Governor *Bernard*. It is necessary to give a summary of the state of politics at that time, to account for this circumstance. The Ministry and Parliament of Great-Britain, finding the revenue of the kingdom insufficient to discharge the interest of the national debt, together with the annual expenses of government, enormously increased by unmerited pen-

sions, formed a plan for taxing the Colonies towards the supply of their treasury; probably hoping, that by means of the officers necessary to collect the taxes, they should create and secure an extensive influence here, which would favor their design of prolonging our dependence upon them, and on these, and other subordinate principles, they passed the stamp act, the declaratory act, and other acts, calculated as they thought, to accomplish their designs. The Colonies were alarmed; they petitioned and remonstrated without effect; they obstructed in different ways the execution of these acts. The British ministry attempted to coerce them to obedience; and introduced a body of soldiers for that purpose. During these times, Mr. BOWDOIN was in the Council, and vigorously opposed all the measures devised to produce compliance: His heart was warmed; and his head and pen, as well as his tongue, employed in the cause of his country: As a philosopher and christian, he was a lover of peace, but he did not inherit from his ancestors, nor had he imbibed from any other source, the principles of passive obedience and non-resistance. He was in every sense a patriot: He connected himself with those who were determined not to be slaves: It was in his power to have made any terms for himself, if he could have deserted his principles; but firm and incorruptible, he put every thing at hazard; this occasioned the measure taken by Governor *Bernard.* But the esteem of his fellow-citizens, and their opinion of his talents and integrity, caused them to place him in the House of Representatives at the next election. When Governor *Hutchinson* succeeded Governor *Bernard,* Mr. BOWDOIN was again elected into the Council, and the choice was approved by the Governor; who thought

it

it necessary however, to apologize to the ministry for this step, by informing them, "That Mr. BOWDOIN's opposition would be less injurious in the Council, than in the House of Representatives." The evidence derived from these facts is of the highest nature; and irresistably prove Mr. BOWDOIN's unequivocal attachment to the rights of his country.

WHEN the town of *Boston* was a garrison, he left his home, and became a fugitive with his brethren. He was elected a member the first American Congress, but did not accept the appointment. This measure has in a later period been misrepresented by those who wished to diminish his influence; but it was the effect of his firmness and independence of spirit: Conscious of his own rectitude, and daring to face calumny as well as the resentment of the British government, he ventured to decline the trust. He found his health, which through life had been tender, too feeble for such an undertaking, in a climate calculated to aggravate his complaints. But did he temporize? Did he leave his country, or its enemies, to doubt of his future conduct? So far from this, that while the British ministry exercised the pageantry of civil government within the province, Mr. BOWDOIN took his station at the head of the Council, who were exercising the supreme executive, and one branch of the legislative authority, and thereby exposed himself to punishment for this conspicuous *overt* act of treason. Through all periods of the war, which was now begun, and which ended with the emancipation of America from the yoke of Great-Britain, he exerted all his talents and devoted himself to the service of his country.

IN

IN the year 1779, the people of Massachusetts, who had for several years, felt the inconvenience of a mutilated government, which was only the remains of that which had been established by the charter, called a convention for the purpose of forming a new constitution for the state: To this convention were returned, from all parts of the commonwealth, as great a number of men of learning, talents, and patriotism, as had ever been assembled here at any earlier period. Mr. BOWDOIN, a delegate from *Boston*, was elected their president: The coolness of their debates, the result of their deliberations, and the constitution which they recommended, confirmed the sentiments which had been anticipated from their character. In this station, Mr. BOWDOIN conducted with a dignified propriety. Patience, attention, candor, and impartiality, the constant attendants of great and honest minds, were qualities which he daily exercised. It is owing to the hints which he occasionally gave, and the part which he took with the committee, who framed the plan, that some of the most admired sections in the constitution of this State appear in their present form: This assembly of wise men carried home with them such impressions of his character, as an able and virtuous statesman, that they retained the highest esteem and respect for him till his death.

IN the month of May, 1780, the act which gives a charter of incorporation to the American Academy of Arts and Sciences, passed the legislature. As our ancestors, in the very infancy of their settlements, convinced that an enlightened people must necessarily be free, established the school at *Newton*, which has since risen to be the university at *Cambridge*; so our political fa-

thers,

thers, impressed with the same liberal principle, and connecting in their views knowledge and freedom, although the country was then engaged in a distressing war, the most important to the liberties of mankind, which was ever undertaken, instituted this society. Mr. BOWDOIN was unanimously chosen our PRESIDENT, and has been annually reelected to the same office. It is in this station that he has been more nearly in our view. It is in this character that we have considered him as our patron, philosopher, and friend. Active in procuring our institution, and persevering in his attention to its interests, he not only promoted our establishment by his influence, but contributed by his literary labours to fill up our design. With this view he wrote and delivered the philosophical discourse, which introduces the first volume of our memoirs; in which are marked his acquaintance with literary subjects, and his ardent desire to advance the objects for which we were incorporated. Not long after he communicated three memoirs, written by himself. In the first, were observations upon an hypothesis, for solving the phenomena of light which Dr. FRANKLIN had raised in opposition to the theory of Sir ISAAC NEWTON. In this, Mr. BOWDOIN, with ingenious perspicuity, and with that friendly freedom which great and candid men use towards each other, examines the hypothesis of Dr. FRANKLIN, and elucidates and confirms that of Sir ISAAC NEWTON, leaving this astonishing genius in possession of his title of the "Father of the Theory of Light," without diminishing the just claims of the American to the discovery of the Electric system, and the means of guarding against its surprising effects. The second and third memoirs, are also on the subject of light, and are an attempt, by a new theory, to account for the

manner in which the waste of matter in the sun and fixed stars, by the constant efflux of light from them, is repaired, and to account for certain luminous phenomena in the heavens, which have been hitherto unsatisfactorily explained. These memoirs afford conclusive evidence that Mr. BOWDOIN was deeply conversant in the principles of natural philosophy; and though the latter memoir suggests a theory which may be liable to some objections, yet the novelty of it, and the ingenious manner in which he has considered it, discovers an inquisitive mind, and a boldness of ideas, beyond those, who, though learned in the knowledge of others, are too feeble to venture on new and unexplored paths of science. If any should be inclined to believe that this system is too visionary, let them recollect, that some of the greatest men the world has produced have fallen into a like error, and that even a BACON, a DESCARTES, a WHISTON, and a BURNET, among the moderns, and a PLATO, a PLINY, and an ARISTOTLE, among the ancients, have advanced theories, which though since found to be defective, has given hints to succeeding philosophers, which have led to some of the most useful and important discoveries that have illuminated and improved the world. Mr. BOWDOIN did not rest here in his endeavors to serve the society; he gave them pecuniary aid in his life time, and bequeathed them by his last will a sum of money, and his large and valuable library.

HE received many letters and personal applications from persons ingenious in mechanic arts, and in plans for extending the manufactures of our country; and the manner in which they were attended to, and encouraged, led them to consider him in an eminent degree as their patron and friend.

THROUGH a large portion of his life, he was, by his station, an overseer of Harvard College, and in the year 1779, he was chosen a fellow of the corporation of that University, in which office he continued until the year 1786, when he resigned it on account of his more public engagements. In the class of his most delectable cares, the exercise of his duties in this office may be considered as standing among the highest. He loved the society; he was fond on all occasions of avowing his relation to it as his literary parent: And as a friend to his country and the interests of religion and learning, he viewed it in a light still more important: He was unceasing in his efforts to serve it, and he contributed by very handsome donations during his life, to render the means of instruction there more useful; and established by his will, a fund for rewarding those students who should be distinguished by their merit.

IN the year 1785, Mr. BOWDOIN was chosen Governor of the Commonwealth of *Massachusetts*: while he received honor from this exalted station, he added to it dignity. No part of the duties of his administration were neglected or carelessly performed. In his correspondencies with the supreme council of the then confederated states, and with those of each of them, he was regular and punctual. No act or resolve of the legislature received his approbation until he had attained a thorough knowledge of its object — comprehended the design of its provisions, and was on the whole satisfied of its salutary effects. In his appointments to offices of civil trust, he was careful and judicious, nor ever prostituted this important and delicate confidence, with which he was entrusted by the constitution, by committing the care of the

property,

property, the lives, the reputation, and the liberty of the citizens to unworthy hands. Although he was by nature, and by his habits, less fitted for military duties, than for those of civil life; yet his arrangements of the militia gave universal satisfaction. Most of the independent corps in the town of *Boston*, and many in other parts of the state, which have been distinguished for their brilliant and soldierlike appearance, were formed under his administration, and he had the pleasure while in office to see the militia as respectable as any that have appeared in this, or perhaps in any country. Respectable foreigners, and citizens of other states, while they were received with proper attention, which gratified their feelings, were impressed with a respect that dignified the government, as well as the Governor.

HE was again placed in the chair in the year 1786, during which year, a cloud arose with so threatening an aspect to the freedom of America, as called for the exertions of all his abilities to dissipate. The insurrection in this state, was an occurrence so interesting at the time, so important in its political effects, and so memorable in the history of this country, that it must engage our attention for a few moments, especially as the character of Mr. BOWDOIN was greatly developed by the part which he acted upon the occasion. Many causes concurred to produce this disturbance: a long war from which this country had but just emerged, had left on the people a heavy debt, which was felt with greater weight, as the taxes had been suffered for some years to accumulate, by the incautious remitness in the collection of them: A depreciating paper currency had thrown many honest people into difficult circumstances: These were aggravated by their see-

ing some of their more artful neighbors suddenly possessed of the property which they had lost, by their confidence in a medium, the operations of which they did not understand. Creditors had been cautious in calling for their debts, while the laws had countenanced debtors in offering them an iniquitous compensation. When government therefore began to exert itself to enforce the collection of taxes, and the courts of law were open to do justice to creditors, a few artful men, of desperate fortunes, and wicked hearts, conceived the design of inciting the people, who were without information of the true state of affairs, to oppose the courts of law, and even to rise in arms to obstruct them. Many people of honest intentions, from whom their views were concealed, were induced to give them countenance, without considering the consequences, which must inevitably follow a state of anarchy, in which the laws, and the regular administration of justice, must be suspended. These combinations were extensive and formidable, and perhaps there was a time in which it was uncertain, whether even a majority of the people were not at least in a disposition not to *oppose* the progress of insurgency. Like causes of uneasiness, in a greater or less degree, existed in most of the confederated states: The contagion appeared to spread, and unless the progress of their success had been suddenly arrested, the flame which was already kindled, would probably have caught the combustibles scattered throughout the states, and have raged with irresistible fury. Mr. Bowdoin was at this time our Governor—in a situation to try the fortitude and resources of any man. Many palliatives were proposed—He was induced for a time to listen to them, and to give his assent to an act, which for

a moment he was persuaded to believe, might relieve them from some of their pressing difficulties, and extinguish the flame. This measure gave pain to some of his best friends. But the views of the leaders in the insurrection, and their secret abettors, went further than their professions, and it became necessary to oppose their progress with force. The majority of his council were found ready to support him, in the most efficient measures. Money, the sinews of war, was wanting—the treasury was empty—but by a meritorious exertion of the merchants, and other gentlemen of property, in which Mr. BOWDOIN himself set an honorable example, ample funds were immediately provided. The militia was called forth, and a gentleman put at their head, whose prudence and abilities, as well as courage, had been often proved. By his spirited exertions, and those of the officers and militia under his command, difficulties apparently insurmountable were overcome. By rapid marches, in the most inclement season, over mountains of snow, almost as difficult to pass as the Alps to the General of *Carthage*, the insurgents and their leaders were panic struck, and fled with precipitancy; and, without the effusion of blood, the rebellion was crushed, and peace and safety restored to the state. The general orders issued by the Governor, shew at once his firmness and circumspection, and his tender concern for the lives and rights not only of the innocent and less blameable citizens, but even of those in an high degree criminal. When we take a retrospective view of this scene, and find such numbers of people, who had so recently been united in resisting the dangers of tyranny; who appeared to understand *so well* the rights of mankind, and the boundaries of civil liberty which

should

should not be transgressed — we are *astonished* that principles should have been so soon imbibed, and a conduct adopted, which brought into such imminent hazard, all they could hold dear, and for which they had so virtuously and successfully contended—We shudder at the idea, that the fair fabric of American liberty and independence, which they had erected, and in which they had placed the altar of freedom, and where was then burning the purest incense, was at once on the point of being overthrown, the flame extinguished, and the dome of tyranny and despotism, the successors of anarchy, fixed on its ruins. But the extremes of good and evil are often marked by imperceptible lines. In this occurrence we may, without a fanciful imagination, trace one of the most operative causes, which gave birth and energy to that system of union, which has since cemented, and, we trust, indissolubly, the freemen of America.

A NUMBER of merchants, and other gentlemen of property, in the year 1784, having procured a charter for a Bank, considered Mr. BOWDOIN, as the person most likely to give them credit, and assure the world of their honor and stability, and placed him at their head as their President.

A SOCIETY afterwards formed under the name of the *Humane Society*, for purposes friendly to humanity, followed their example and gave him the same rank among them.

MR. BOWDOIN'S reputation as a man of science and virtue, was not confined to the United States of America. Distinguished honors were conferred on him by many learned societies. He was made L. L. D. by the universities of *Cambridge*, *Philadel-*

phia,

phia, and *Edinburgh*; Fellow of the Royal Society of *London*; Fellow of the Society of Arts, Manufactures and Commerce of *London*; and he maintained through life an extensive correspondence with men of taste and learning.

HIS last public appearance in a political character, was in the Convention of this state, appointed in the year 1788, to consider of the Constitution of the United States. On this, as on a former occasion of like nature, but of less importance, many gentlemen, who, from their private employments and love of retirement, had declined engaging in the busy scenes of politicks, assembled to deliberate on a plan of government, which might for many generations affect the liberty and happiness of the citizens of America. In this assembly, so respectable for the great and virtuous characters which composed it, Mr. BOWDOIN appeared as a Representative for his native town. Here he again became a strenuous advocate for a form of government, calculated as he conceived, to produce that security, which is the ultimate desideratum in all social compacts, and which security depends on the introduction of such checks, as may at all times balance the dangers, which arise to true freedom, from the occasional preponderancy of aristocratic or democratic principles. Here he reasoned with pertinent force, and his speech on the occasion, printed among the debates of that convention, demonstrates his thorough acquaintance with the principles of government, and his ability to support them. He gave his voice for the adoption of the constitution, not because he thought it merely preferable to the feeble structure of the confederation, or that the salutary provisions of it overbalance those which were exceptionable; but from a full conviction,

that

that it was probably one of the best, that human wisdom could devise.

THE character of Mr. BOWDOIN has hitherto been principally considered in those points of view, in which he has been placed by his public stations. But the history of his private life is no less honorable to himself, nor less useful and instructive to the world. He early established for himself a system of order, which enabled him through a life, greatly conversant with public affairs, to possess a dignified leisure. He was never unduly pressed for time, to perform all his duties; to gratify the bent of his speculative taste for literary pursuits; or to solace himself in his rational amusements with his domestic connections. The same order enabled him so to conduct his property as to avoid confusion and waste, and to be ever ready to apply it to the purposes of hospitality and beneficence.

HE was an open and unreserved professor of the christian religion, and in the form usually practised in this country. He was not ostentatious, enthusiastic, or intolerant; but it was on religion as the firmest basis, that he rested all his hopes, and from which he derived his consolation. He was a friend to the clergy, *not only* of his own religious denomination, but of all others. He received them with courtesy; he encouraged them with his countenance, and he frequently relieved their pecuniary difficulties. They repaid him with affection; and they have shown a respect for his memory by the affliction which they unaffectedly exhibit at his death.

I MIGHT with the strictest truth, point out many other excellent traits in his character, but to those who knew him, their own knowledge will supply the deficiency; and with those who did not, I might incur the censure of deviating from the rules prescribed me. It may be said that our country has produced many men of as much genius; many men of as much learning and knowledge; many of as much zeal for the liberties of their country, and many of as great piety and virtue. But, is it not rare indeed, to find those in whom they have all combined, and been adorned with his other accomplishments?

WE now approach to that scene, in which all men must at last act. The wise, and the foolish; the learned, and the ignorant; statesmen, and men in humble life, are here placed on a level; yet it is in that scene, in which, whatever characters they have borne, or have assumed, the mask, if any they have worn, must drop forever. Mr. BOWDOIN, still in the possession of the undebilitated powers of his mind, and when his friends promised themselves much from his experience and example, was attacked by a most painful and fatal disorder, under which he lived several months, but in the full view of approaching death. Let us draw near his couch: We shall there see him suffering the most excruciating pain; but sustaining it with fortitude; revising that disposition of his temporal affairs, which his love of order, had induced him to make in health; his heart overflowing with gratitude for the blessings he had enjoyed; willing to live, but not afraid to die; his hopes lively and animated; not supported by any visionary dreams of enthusiasm, but by the rational belief of the

religion

religion he had professed, and on the retrospect of a life, which had been conducted by its principles, and at last quitting it like a philosopher and christian.

HE died on the sixth day of *November*, 1790. By his will he gave to the Religious Society with whom he was connected, and to their Minister, as well as to the University at Cambridge and to this Academy, very handsome legacies.

THE general anxiety which had for some weeks been manifested by an inquisitive solicitude for his safety, was now changed into expressions of sorrow at his death.

GREAT and respectable was the concourse which attended his funeral—every species of occupation was suspended—all ranks and orders of men—the clergy and the laity—the magistrate and the citizen—men of leisure and men of business—testified their affection and respect, by joining in the solemn procession—and crowds of spectators lined the streets through which it passed—while an uncommon silence and order every where marked the deepness of their sorrow. And can we, my brethren, part with our friend, our brother, and our head, without regret? Can we recollect, without emotion, the many pleasing and instructive hours we have passed with him, in his closet, in our meetings, and at his social board? Can we forget his virtues? or can we, without the most pungent sorrow, reflect that the heart which they once filled, now ceases to beat? and the eye through which their emanations were conveyed, is closed forever? Is it less philosophical to indulge the tear, that flows from those principles of

sympathy

sympathy which expand and elevate the heart, and dignify the man, than to affect a cold apathy which nature, or its author, has never given him? No—let us feel, but submit—let us deeply engrave on our minds the impressions of his character, and animated by his virtues, imitate his example.

was fixed, that I was not so far satisfied with them at the time, as to suppose they could be safely used to determine the least distance of centres: but was persuaded, that if the observations of the two last contacts should be as favourable as those of the two first, the least distance of centres, and the latitude of Mercury, might with more accuracy, be deduced from the contacts, than from any of the micrometer measures. I did not attempt, on the same account, to measure Mercury's semidiameter by the micrometer, but left it to be determined from the contacts. As the Sun's diameter was a large angle, and could more easily be taken than small ones, I applied the micrometer several times, to measure it, when the wind was least troublesome; and found it, parallel with the horizon, to be 32′ 24″ 33.

The atmosphere was perfectly clear at the time of the two last contacts; and I found the internal one happened at 1^h 15′ 44″. P. M. and the external one at 1^h 17′ 36″ P. M. both apparent time.

I took corresponding altitudes of the Sun on the day of the transit; and found, that when it passed the meridian, it was, by my clock, using the proper equation for change of declination, 11^h 59′ 36″ 22‴. From the 2d of November therefore, to the 5th, the clock had gained upon apparent time 3″ 5‴. If it had kept mean time exactly, it would have gained 3″ 54‴. Hence it appears, that it deviated but about $\frac{1}{4}$ of a second in twenty four hours, from keeping mean time.

Having had so good observations of this phenomenon, I thought it my duty to communicate them to the Academy.

And I shall conclude the paper by making those deductions from them, which I hope, may in some measure, subserve the interests of Astronomy.

The elements for the calculations are from M. Mayer's Tables of the Sun, published in the year 1770, and M. de la Lande's Tables of Mercury, in the first volume of the second edition of his Astronomy, published in the year 1771; reckoning the difference of meridians between Cambridge, and the Royal Observatory at Greenwich, $4^h\ 44'\ 31''$; and between Cambridge, and the Royal Observatory at Paris, $4^h\ 53'\ 47''$.

By these tables we find ☿'s distance from the Sun, reduced to the ecliptick, at the time of the conjunction, Log. 4. 498326, in numbers = 31501; the Sun's distance from the earth, Log. 4. 995777, in numbers = 99032; Mercury's distance from the earth therefore, in numbers, was 67531 = Log. 4. 829503. By the best calculations, from the observations of the transit of Venus, made in the year 1769, the Sun's horizontal parallax, on the day of the transit of Mercury, must have been $8''.\ 85$. Having these requisites, we may find Mercury's horizontal parallax thus:—— ☿'s distance from the earth: ☉'s distance from it : : ☉'s horizontal parallax : ☿'s horizontal parallax; which is found = $12''.\ 978$: consequently, ☿'s horizontal parallax from ☉ = $4''.\ 128$.

The Sun's horary motion, during the transit, was $2'\ 30''.\ 7$: Mercury's heliocentrick horary motion in longitude in the ecliptick, at the time of the first external contact, was $14'\ 59''$; and at the time of the second, $15'\ 3''$: consequently, his motion from the Sun, $12'\ 28''.\ 3$ and $12'\ 32''.\ 3$;

from

from which we may find Mercury's horary motion upon the Sun's disc, with respect to the ecliptick, at the beginning of the transit, 5′ 49″. 059; and at the end, 5′ 50″. 955. This was the compound motion of the Sun and Mercury; Mercury's motion being retrograde. If therefore, we substract the Sun's horary motion, we shall have Mercury's geocentrick horary motion in longitude, at the beginning of the transit, 3′ 18″. 359; and at the end, 3′ 20″. 255.

Mercury's heliocentrick motion in longitude, from 8^h 24′ 4″, the time of the first external contact, till 10^h 39′ 31″, the time of the ecliptick conjunction, by the tables, was 33′ 50″. 1, making 28′ 9″. 9 from the Sun, and 13′ 8″. 29 for his motion upon the Sun's disc, which makes his geocentrick motion in longitude 7′ 28″. 09. The similar motions, from 10^h 39′ 31″ to 1^h 17′ 36″, the time of the second external contact, were 39′ 35″. 2, 32′ 58″. 2, 15′ 22″. 77 and 8′ 45″. 77. Mercury's horary motion in latitude, at the beginning of the transit, was 51″. 404; and at the end, 51″. 685; and from 8^h 24′ 4″ to 10^h 39′ 31″, 1′ 56″. 011; and from 10^h 39′ 31″, to 1^h 17′ 36″, 2′ 16″. 115, decreasing.

The longitude of the Sun therefore, and Mercury's geocentrick longitude by the tables, at 10^h 39′ 31″, being 7^s 13° 40′ 56″. 5; and the latitude of Mercury, 7′ 27″. 95, we shall find,

At the time of the first external contact, viz. 8^h 24′ 4″ A. M.

☉'s longitude.	7^s 13° 35′ 16″. 3
☿'s geocentrick longitude.	7 13 48 24. 59
☿'s geocentrick latitude.	9 23. 961
☉'s right ascension.	221 7 34

Right

Right ascension of the mid heaven.	167° 8′ 34″
Which being substracted from 270°, gives < at the pole.	102 51 26
☉'s semidiameter, by observation.	16 12. 125
The obliquity of the ecliptick.	23 28 0
Latitude of Cambridge, 42° 23′ 28″ N. reduced to centr.	42 8 37

From these elements, we find the longitude of the nonagesimal degree, 4^s 26° 32′ 44″, and altitude, 55° 49′ 42″, and Mercury's parallax in longitude from the Sun, 3″. 333; and in latitude, 2″. 322.

At the time of the second external contact, viz. 1^h 17′ 36″ P. M.

☉'s longitude.	7^s 13° 47′ 33″. 5
☿'s geocentrick longitude.	7 13 32 10. 73
☿'s geocentrick latitude.	5 11. 835
☉'s right ascension.	221 19 45
Right ascension of the mid heaven.	240 43 45
Which substracted from 270°, gives < at the pole.	29 16 15

From these elements we find the longitude of the nonagesimal degree, 7^s 6° 22′ 32″, and altitude, 34° 15′ 56″, and Mercury's parallax in longitude from the Sun, 0″. 29; and in latitude, 3″. 416.

At 8^h 29′ 52″ A. M. the apparent time of ☿'s first internal contact, his parallax in longitude from the Sun, was 3″. 323; and in latitude, 2″. 329.

At 1^h 15′ 44″, P. M. the apparent time of ☿'s second internal contact, his parallax in longitude from the Sun, was 0″. 318; and in latitude, 3″. 412.

For

For ☿'s semidiameter by the observation of the contacts, and also his latitude, together with the time of the ecliptick conjunction: In fig. 8, Plate I. let E S K represent the southern half of the Sun's disc; the diameter E ⊙ K a portion of the ecliptick, or rather a line parallel to it, being removed from it = the Sun's parallax in latitude; C ☿ Mercury's visible geocentrick latitude at the time of the first external contact; L M his visible geocentrick latitude, at the time of the second external contact; the line M U drawn from the point M parallel to K E = Mercury's visible motion upon the Sun's disc, between the two external contacts, reduced to the ecliptick; consequently, ☿ U = his visible motion in geocentrick latitude, during the time which passed between the two external contacts. Therefore, ☿ M is the visible transit line; and ☿ M U, the angle which this line makes with the ecliptick. The point ⊙ is the Sun's centre, at the apparent time of the visible conjunction of centres; ⊙ N perpendicular to ☿ M, the visible least distance of centres; ⊙ D perpendicular to the ecliptick, the visible distance of centres, at the time of the visible ecliptick conjunction; ☿ ⊙ and M ⊙ = the sum of the semidiameter of the Sun and Mercury, the distance of centres, at the time of the external contacts; ⊙ i and ⊙ r = the Sun's semidiameter, the distance of centres, at the time of the contacts of Mercury's centre with the Sun's limb; C U = U F, the visible difference of longitude of the centres, at the time of the first external contact, and ⊙ L the visible difference, at the time of the second.

The

The longitude of the nonagesimal degree, at the time of each contact, being less than the longitude of Mercury, the parallax in longitude is to be added to Mercury's longitude, at the time of each, to give the visible; and as Mercury's motion in transits is retrograde, and the parallax, at the time of the second external contact, was greater than at the time of the first, the length of the visible transit line was greater than the true, by the difference of the parallaxes.

The true latitude, at the time of each contact, was increased by the parallax in latitude; and as the geocentrick latitude was decreasing, and the parallax, at the time of the second external contact, was greater than at the time of the first, the visible motion in latitude was less than the true, by the difference of the parallaxes. Hence, we may easily find MU and ☿U as follows:

☿'s parallax in lon. from ☿ at 1st ext. cont.	3″. 333
Do. at 2d.	0. 29
Difference.	3. 043
☿'s motion on the ☉'s disc, with respect to the ecliptick, in 4^h 53′ 32″.	28′ 31″. 06
	= 1711″. 06
Add the difference of parallaxes in longitude.	3. 043
The Sun is = MU.	1714. 103
☿'s parallax in lat. from ☉ at 1st ext. cont.	2″. 322
Do. at 2d.	3. 416
Difference.	1. 094

☿'s true

☿'s true motion in geocentrick lat. in 4^h 53′ 32″. 4 12. 12
= 252″. 126

Subtract the difference of parallaxes in latitude. 1. 094

Visible motion in geocentrick latitude = ☿ U. 251. 032

Having found M U and ☿ U, we easily find the length of the visible transit line ☿ M, as follows: M U, 1714″. 103 : ☿ U, 251″. 032 : : Radius : Tangent < ☿ M U, 8° 19′ 54″. 5 : Then Sine < ☿ M U, 8° 19′ 54″. 5 : U ☿ 251″. 032 : : Radius : ☿ M, 1732″. 39; the half of which, viz. 866″. 195, = ☿ N, or M N.

Having obtained ☿ N and M N, we may proceed to find ☿'s semidiameter by observation.

At the time of the first contact, ☿'s horary motion on the ☉'s disc, reduced to the ecliptick, was 5′ 49″. 059: therefore, in 1′ 48″, the time from the first external to the first internal contact, the motion was 10″. 472. At the time of the last contact, the horary motion, with respect to the ecliptick, was 5′ 50″. 955, which gives 10″. 917 for ☿'s motion upon the ☉'s disc, in 1′ 52″, the time between the second internal, and second external contact. The difference of the parallaxes between the first external, and first internal contact = 0″. 01, being added to 10″. 472, will give the visible geocentrick motion of ☿ upon the ☉ with respect to the ecliptick, 10″. 482 in 1′ 48″; and the difference of the parallaxes between the second internal, and the second external contact = 0″. 028, being added to 10″. 917, will give 10″. 945, for the visible geocentrick motion of ☿ upon the ☉, with respect to the ecliptick, in 1′ 52″. ☿'s true motion in geocentrick

latitude,

latitude, in 1′ 48″ was 1″. 546; from which substract 0″. 007, the difference of the parallaxes in latitude in that time, and we shall have 1″. 539, for ☿'s visible motion in geocentrick latitude. In 1′ 52″, ☿'s true geocentrick motion in latitude, was 1″. 603; from which substract the difference of parallaxes in latitude, 0″. 004, and we shall have 1″. 599, for ☿'s visible motion in latitude. With these visible motions in longitude and latitude, we obtain 10″. 594 for ☿'s visible motion in his path upon the Sun's disc, in 1′ 48″, and 11″. 061, for his motion in 1′ 52″.

The mean of 10″. 594 and 11″. 061, the motion of ☿ in crossing the Sun's limb, at the ingress and egress, is 10″. 827; the half of which, viz. 5″. 414, being substracted from 866. 195, half the transit line, between the two external contacts, will leave 860. 781 = half the transit line, between ☿'s central contact. = N i, or N r. Let the observed semidiameter of the Sun = 972″. 125, be diminished 4″. 5, for irradiation or inflexion, and we shall have 967″. 625, for his semidiameter, to be used in these calculations; this is = ⊙ i or ⊙ r. Therefore, in the right angled plain triangles, ⊙ ☿ N and ⊙ M N, we have the hypothenuse, ⊙ i or ⊙ r, and side, ☿ N or M N, to find side ⊙ N; which is obtained by multiplying together the sum and difference of the hypothenuse and leg, and extracting the square root of the product, which is easily done by logarithms. Thus ⊙ N is found = 442″. 071.

Having found ⊙ N, let us assume 5″ for the semidiameter of ☿, which added to the Sun's semidiameter, diminished by inflexion, will give 972″. 665, for ⊙ ☿ and ☿ M; and substracted, will give 962″. 665, for ⊙ s and ☿ x; from which we

may

may easily find N ☿ and N s, and N M and N x; and consequently, obtain the spaces which Mercury would have run through between the external and internal contacts, had his semidiameter been equal to that assumed. These spaces are ☿ s and M x, each = 11″. 242; but the spaces run through by observation, were not so great; therefore, ☿'s semidiameter by observation, was less than that which we have assumed, and may now be exactly obtained. ☿'s by observation, was 10″. 594, therefore, 11″. 242 : 5″ : : 10″. 594 : 4″. 712. M x by observation, was 11″. 061; therefore, 11″. 242 : 5″ : : 11″. 061 : 4″. 919. From these results it appears, that ☿'s semidiameter by the observation of the two first contacts, was 4″. 712; and by the observation of the two last, 4″. 919; the mean of which is 4″. 815; which we may use as the semidiameter of ☿, in the calculations which follow.

For ☿'s geocentrick latitude at the time of the external contacts:

We have already found ☿ ⊙ U = N ⊙ D = 8° 19′ 54″. 5, and ☿ N, the visible transit line = 1732″. 39, the half of which, viz. 866″. 195, is = ☿ N or M N; also ☿'s semidiameter by observation = 4″. 815, which added to ⊙'s reduced semidiameter, 967″. 665, will give 972″. 48 = ⊙ ☿: Therefore, ☿ N 972″. 48 : Radius : : ☿ N 866″. 195 : Sine < ☿ ⊙ N 62° 57′ 44″. 2. From this substract < N ⊙ D, 8° 19′ 54″. 5, and the remainder, viz. 54° 37′ 49″. 7, will be = < ☿ ⊙ D; the complement of which angle, viz. 35° 22′ 10″. 3 will be = < ☿ ⊙ C; because D ⊙ C is a right angle. Having found < ☿ ⊙ C, we may say, Radius : ⊙ ☿, 972″. 48 : : Sine < ☿ ⊙ C, 35° 22′ 10″. 3 : C ☿, 562″. 917 = 9′ 22″. 917

9′ 22″. 917 = the visible difference of latitude between the Sun and Mercury, at the time of the first external contact; from which substract Mercury's parallax in latitude from the Sun = 2″. 322, and the remainder, viz. 9′ 20″. 595, will be Mercury's true latitude by observation. The latitude by the tables, being 9′ 23″. 961, the errour is + 3″. 366.

For the difference of longitude of the centres of the Sun and Mercury at the time of the first external contact, and consequently at the time of the ecliptick conjunction:

Radius : ⊙ ☿, 972″. 48 : : Sine < ⊙ ☿ C, 35° 22′ 10″. 3 : C ⊙, 792″. 995, the visible difference of longitude of the Sun's and Mercury's centre; from which substract 3″. 333, Mercury's parallax in longitude from the Sun, and the remainder, viz. 789″. 662, will be the true difference of longitude by observation.

Mercury's heliocentrick motion in longitude from 8^h 24′ 4″, A. M. to 10^h 39′ 31″, A. M. viz. in 2^h 15′ 27″, was by the tables, 1689″. 9; which will give 788″. 29 for his geocentrick motion on the Sun's disc, reduced to the ecliptick. Therefore, 788″. 29 : 2^h 15′ 27″ = 8127″ : : 789″. 662 : 8141″ = 2^h 15′ 41″; which added to the time of the first external contact, viz. 8^h 24′ 4″, will give 10^h 39′ 45″, A. M. for the apparent time of the true ecliptick conjunction by observation; being 14″ later than by the tables.

At 10^h 39′ 45″, the Sun's longitude was 7^s 13° 40′ 57″. 1; consequently, it being the ecliptick geocentrick conjunction, Mercury's geocentrick longitude was the same, which makes his heliocentrick longitude at that time, to have been 1^s 13°

40′ 57″. 1

40′ 57″. 1; but by the tables, it was 7^s 13° 41′ 0″. 0, Mercury's errour therefore, in longitude, was + 2″. 9.

For Mercury's heliocentrick latitude, at the time of the ecliptick conjunction, by observation, and his distance from the node:

In 2^h 15′ 27″, or 8127″, ☿'s motion in geocentrick latitude by the tables, was 1′ 56″. 011 : Therefore, 8127″ : 116. 011 : : 8141″ : 116″. 213 = 1′ 56″. 213. This was Mercury's motion in latitude, in 2^h 15′ 41″; which being substracted from 9′ 20″. 595, his geocentrick latitude, at the time of the first external contact, will give 7′ 24″. 382, for his geocentrick latitude, at the time of the observed ecliptick conjunction: Then ☿'s distance from the Sun : ☿'s distance from the earth : : ☿'s geocentrick latitude, 7′ 24″. 382 = 444″. 382: ☿'s heliocentrick latitude, 952″. 578 = 15′ 52″. 578.

Let ☊ E. Fig. 9. be a portion of the ecliptick; the point ☊ the place of ☿'s ascending node; ☊ ☿, a portion of ☿'s heliocentrick orbit; the point at ☿, his heliocentrick place in his orbit, at the time of the ecliptick conjunction; and E, his place reduced to the ecliptick; E ☿, his heliocentrick latitude; the angle E ☊ ☿, the inclination of his orbit = 7° 0′ 0″. In the right angled spherick triangle, right angled at E, there are given the angle E ☊ ☿, and the perpendicular or side E ☿, to find the base or side ☊ E = Mercury's distance from the ascending node:

Radius : Tangent, E ☿, 15′ 52″. 578 : : Tangent co $<$, E ☊ ☿, 83° 0′ 0″: Sine, ☊ E, 2° 9′ 20″ = ☿'s distance from the ascending node.

At

At $10^h\ 39'\ 45''$, A. M. the time of the ecliptick conjunction, ☿'s heliocentrick longitude was $1^s\ 13°\ 40'\ 57''.1$; from which substract the equation of the node, $13''.7$, because the heliocentrick latitude is found for the longitude unequated;

The remainder is	1^s	$13°$	$40'$	$43''.4$
To which add ☿'s distance from ☊ because ☿ was advancing to ☊		2	9	20
The sum is the place of the ascending node	1	15	50	3.4
Place of ☊ by M. de la Lande's tables of 1771	1	15	51	8
Errour of the tables.		+	1	4.4

PHYSICAL.

Plate I

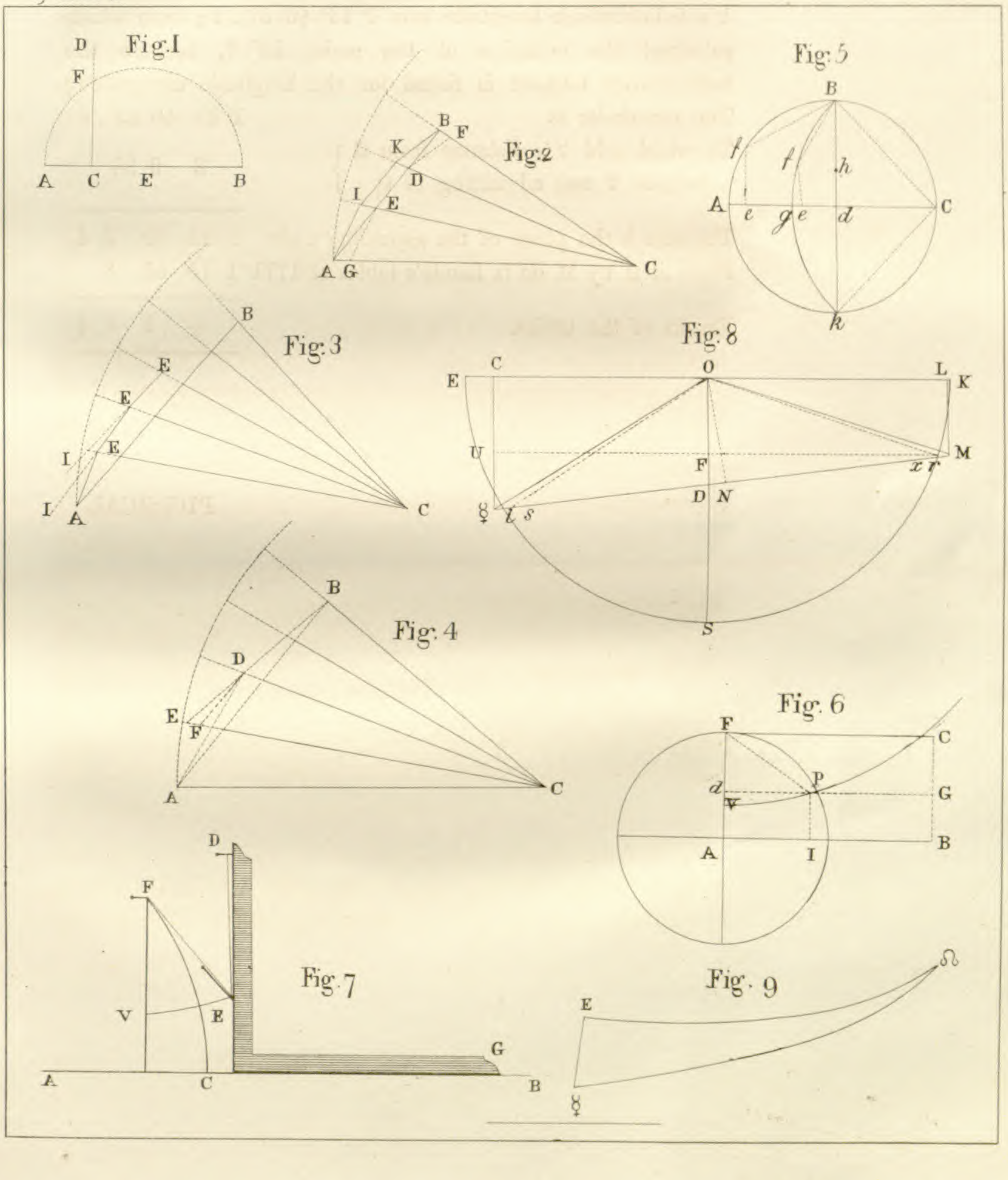

Fig. I
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Fig. 2
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Fig. 3
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Fig. 4
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Fig. 5
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Fig. 8
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Fig. 6
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PHYSICAL PAPERS.

I. *Observations on Prismatick Colours, by Doctor* SAMUEL TENNEY, *of Exeter*, F. A. A.

Exeter, 24th *March*, 1791.

DEAR SIR,

I HAVE long entertained some doubts of the accuracy of Sir Isaac Newton's theory of colours: and as "*Nullius addictus jurare in verba magistri*," is the general motto of modern enquirers after truth, I hope, that a modest attempt to point out an errour in it, accompanied with a sincere wish to have my own opinion rectified, if it should appear to be wrong, will not be esteemed an act of disrespect to so great a name.

The part of Sir Isaac's theory, with which I am dissatisfied, is the number of colours inherent in the rays of light. That a pencil of rays is uniformly separated by the prism, into seven portions, exhibiting each a different colour, is evident to the sight; and that all other colours are made up of different combinations of these, follows of course. That some of the prismatick colours are also mere compounds, I shall endeavour to prove.

The justness of Sir Isaac's *Rules of philosophizing* has never, to my knowledge, been called in question. One of these directs us to "admit no more causes of any phenomenon than are necessary for explaining it": — and another asserts, that

that "to natural effects of the same kind, we are, as far as may be, to assign the same causes." Let us first examine the doctrine by these rules.

Three of the prismatick colours we may every day, see produced by composition. *Orange* is evidently composed of red and yellow; *green*, of yellow and blue; and *purple*, of blue and violet. Nature, in the vegetable kingdom, is continually producing and destroying them. Unripe oranges are green; as they ripen, the blue particles give place to red; which, with the more fixed yellow, form the colour denominated from the fruit. The green colour of many plants is changed, as they decay, into some of the shades of yellow, by the escape of those particles which reflect blue rays. And almost every body knows, that cloths are coloured green, by being dipped successively in blue and yellow dies. Purple may, in like manner, be produced by a mixture of blue and violet liquors or powders.

Now, is it consistent with the above cited rules to admit orange, green, and purple to be compound colours in all terrestrial bodies; and at the same time to assert, that they are simple and original in the rays of light? Is it not rather totally repugnant to them both? Further, writers on the subject allow, that all natural colours, not excepting white, may be imitated by a mixture of proper proportions of red, yellow, blue, and violet. Whence then, arises the necessity of admitting three others to exist in light? But, if orange, green, and purple be really original colours, inherent in the rays of light, how does it happen, that these alone are capable of being imitated by composition? On Sir Isaac's theory, these

queries

queries do not appear to me to admit of a satisfactory solution.

To this reasoning, it may probably be answered, that in all enquiries of this kind, theory, however plausible, must ever give way to experiment. The prism actually separates a pencil of rays of light into seven distinct colours: they must therefore, exist in it. To this I would reply, that we ought not to suffer ourselves to be deceived by appearances. In chemical decompositions, we know, that most of the substances obtained are themselves compounded; and may, by another process, be again separated into more simple bodies. Why may not this be true of some of the colours, produced by the prismatick decomposition of light? In fact, I strongly suspect a fallacy in the experiment, which has given rise to a false deduction. Did either of the three colours, which we find to be producible by composition, hold the first, or the last place in the prismatick series; or, were any two of them found together, no further proof of their simplicity could reasonably be demanded. But instead of this, they appear precisely in the places, which they ought to possess, on the supposition of their being compounded. Orange is found between red and yellow; green, between yellow and blue; and purple, between blue and violet.

The existence of all the colours discovered by the prism, as simple and original, depends entirely on the truth of a postulatum, which I apprehend has never been fully established, viz. that the prism effects a complete separation of the different coloured rays. For if the separation be imperfect, intermediate colours must be produced. Now, can

it

it be proved, that all rays of the same colour possess precisely the same degree of refrangibility? Two circumstances concur to render it, at least probable that they do not. The first is, that the space occupied by any particular colour, in the prismatick picture, is so much wider than the aperture, through which the light is admitted upon the prism, for the experiment. For, if all the rays of that colour were equally refrangible, the picture could be no wider than the aperture; and would be terminated by well defined edges: which is the result of this law of refractions, that parallel rays, of the same refrangibility, perpetually maintain their parallelism. The second circumstance is, the unequal widths of the several colours in the prismatick picture. Now, as this cannot arise from the greater or less quantity of rays, which would produce only different degrees of intensity, it must proceed from this: that the rays of those colours which form the widest pictures, possess different degrees of refrangibility among themselves: in consequence of which, they are scattered over a greater space. This being allowed, it is highly probable, that some red, and some yellow rays may be equally refrangible; in which case, they must, at their exit from the prism, be necessarily blended. The same may hold good of the other rays, some yellow and blue, some blue and violet remaining unseparated; from all which combinations will arise the orange, green, and purple colours.

Should it be here asserted, that these arguments prove only that rays of the same colour, suffer a dispersion from the imperfection of the refracting medium, I would answer, that although it would be impossible to account for the

second

second appearance above mentioned, and its uniformity in all experiments, on this supposition; yet, if granted, it will answer all the purposes of my argument: for this dispersion of rays, however occasioned, whether by a different refrangibility in rays of the same colour, or by the imperfection of the prism, will occasion an intermixture of neighbouring, simple colours; from which the same compound colours must proceed, that are produced by the same mixtures in bodies, with which we are more intimately acquainted.

I know not with what force these reasonings will strike those, who are not influenced by the partiality which a man commonly feels for his own ideas; but to me, they appear sufficient to warrant a modest conviction, that the original colours, or those inherent in the rays of light, ought to be reduced to these four, Red, Yellow, Blue, and Violet; and that the other three, Orange, Green, and Purple, though among the most pleasing colours, should be degraded from the rank, which they have long unjustly held; and considered as only some of the most simple of those, that are formed by composition.

After all, Sir, I am sensible it will be said, that in such enquiries, experiment is the only test of truth. It happens rather unfortunately for me, that, if I am right in my principle, that rays of the same colour possess different degrees of refrangibility, the case hardly admits of an experiment which can be decisive. On the other hand, if what I impute to this cause arise entirely from the imperfection of the prism, a second prism, so placed as to take only one of those colours, which I esteem compound, might determine the point. For instance, if orange be an original colour, the second prism

 could

could produce no change in it: but, if it be a compound, this second operation, by separating the red from the yellow rays, would annihilate it. But, on the former hypothesis, that some red, and some yellow rays may be equally refrangible, this experiment would be indecisive; because no separation would be effected by it. I think of one experiment, by which (if it be practicable) some light may be thrown on the subject, though perhaps, not sufficient to discover where the truth lies. This is, to place four prisms in such situations, that the red rays of one, and the yellow of another, may be thrown together by the other two. If the common prismatick orange should be thus produced, it would be a strong circumstance in favour of my hypothesis.

As I have no prisms within my reach, to make these, or any other experiments, relative to the subject, it is not in my power. As I wish to have my ideas either verified or disproved, if you have among your acquaintance any one, who, being possessed of the necessary apparatus, will take the trouble of making some few such experiments, as the hints I have given, or his own ingenuity, may suggest, you will oblige me by turning his attention to the subject. And should you judge this epistolary essay to be worthy of the notice of the American Academy of Arts and Sciences, I beg you will do me the honour to present it.

I am, my dear Sir,

with every sentiment of esteem,

your most devoted,

and humble Servant,

SAMUEL TENNEY.

The Rev. Mr. BELKNAP, F. A. A.

II. *An*

II. *An Account of a Number of Medicinal Springs at Saratoga, in the State of Newyork, by Dr.* SAMUEL TENNEY.

Saratoga, September 1, 1783.

DEAR SIR,

YOU may probably recollect, that the last time I had the pleasure of seeing you, I mentioned some mineral springs, in the vicinity of this place, which I had not then seen. I joined the regiment soon after, and took the first opportunity to visit them; and, I assure you, I never had less reason to repent of any pains taken to gratify my curiosity in my life. They are such a production of nature as is calculated, not only to attract the notice, and excite the admiration of the illiterate; but to engage the attention of the physician, the chemist, and the philosopher.

They were unknown (except to the Mohawks, in whose country they are found) 'till about thirteen years ago; at which time they were discovered by some surveyors. The land, for several miles round them, is a wilderness. They have been considerably frequented by the poorer sort of people, ever since their discovery; but for want of proper medical directions, and necessary accommodations, their usefulness has been hitherto much confined. I think they want only a suitable introduction to the world, and some convenient houses for boarding and lodging patients, to render them, under the advice of judicious physicians, of very important service to the country. Whether my expectations are too sanguine, time will discover. In the interim, for your satisfaction, I will first give a description of the wells —

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in the next place, some experiments which I made on their waters, with such observations as naturally occurred to me in consequence of them — and then relate their effects, in such cases as I had an opportunity of observing, with some general remarks respecting their medicinal properties.

The springs are about ten in number; of which the extremes may be half a mile apart. They are situated about fourteen miles northwesterly of General Schuyler's seat, at Saratoga, in a kind of bog meadow, a few rods wide, through which runs a pleasant brook of sweet water. The land on each side of the meadow, rises fifteen or twenty feet above it; on the side next the springs, stony, but fit for cultivation; on the opposite side, sandy and barren. The bank adjoining some of the principal springs is very steep, and bound with a broken ledge of lime rocks, generally incrusted with flint, to the thickness of near an inch. This incrustation, which is unequal and ragged, gives them a very curious appearance. This ledge does not extend more than fifteen or twenty rods. From the place where it terminates, to the upper spring, there is an easy declivity from the level land above, to the margin of the meadow. For some distance in this extent, the brook, which like most others, winds through the meadow in a serpentine course, runs close to the bank. This part is, in some places, completely bridged over, for several rods, with large tables of stone, of about a foot thick; which were evidently shaken off the declivity, and shot over the bed of the stream. The bank, though it is covered with a considerable stratum of earth, appears to consist principally of a solid mass of rock,

whence

whence those large plates were shaken. The remaining part is, in many places, cracked into deep fissures, two or three feet wide, and generally covered with tables, similar to those above mentioned. In other places they are open, and discover long subterraneous vaults. These ruins extend perhaps twenty rods, and were doubtless, if we may judge from present appearances, produced many ages since, by some very violent convulsion of nature.

I have been induced to be thus particular in my description of the neighbouring bank, not only from its singularity, but likewise on account of a conjecture which I shall hereafter venture to make, that there may be some connexion between the causes of those appearances, and those that gave rise to the springs.

I shall now attempt a description of the springs, beginning with the uppermost. This is about two rods from the foot of the bank; the intervening meadow, a deep mud. This spring may be more properly termed a well. It is of an oval figure, and about three feet in its longest diameter. Its depth is undiscovered, though it has been sounded with a pole many feet long. It is perpetually emitting an infinite number of air bubbles, from the size of those in a glass of bottled cider, to that of a marble toy. This ebullition is constant, though not uniform. The larger will frequently intermit for a short space, and then recommence with renewed force.

The stream of water from this well, is not much larger than might pass through a large goose quill. The well is in the centre of a stony substance (raised about three feet above the surface of the meadow) which makes the perpendicular

walls

walls; and gradually inclining, terminates at the distance of eight or ten feet from it. This stony concrete is soft and friable; and when broken off where it is wet, smells like a fresh oyster shell.

A few rods from this is another spring of the same kind, which discharges a still smaller quantity of water, and has but little stony matter about it. From appearances, I cannot but conjecture, that this must be of much later date than the former. There is one circumstance which renders it more than probable: the former was, 'till within a few years, surrounded with several others (some say ten or twelve) within the extent of the surrounding concretion. The orifices of these, several of which are still visible, are become impervious. The water therefore, formerly discharged by them, must have found vent by some other course; as it is hardly probable that it could find admittance into the main well, through its solid sides, it is natural to suppose that it might go off in a lateral direction, where it found the least resistance, and force a passage in this place.

The next spring of any importance, is at about the same distance from the bank as the first; and differs from it, in discharging a less quantity of water, and in being a kind of pool, instead of a well. The area is an irregular parallelogram, of about eight feet by five, and near two feet deep. It is surrounded by an equal quantity of the same stony substance as the first, with which, as I have been informed, it was formerly nearly covered. But the stone being soft and friable, part of it was broken away soon after its discovery, to render it commodious for bathing: the remainder has

been

been beat down by some means, not long since. From the foot of the ledge of rocks, above described, and within two rods of this pool, issues a considerable spring of very good sweet water.

The last that demands a particular description, proceeds from the solid ground, about a rod from the foot of the ledge, and at the same distance from the margin of the meadow. This is a well whose walls are a solid rock, of a conical form, about five feet high, with a pretty broad base. Near the ground, however, this rock is light and porous, with a mixture of vegetable substances, and here and there, the shell of a very minute muscle or snail. The heavy compact part is divisible into small scales, and is of a cream colour, interspersed with some light shades of red and yellow.

The cavity of this well is perfectly round at the top, and about nine inches in diameter. It grows wider as it descends, and becomes irregular in its figure. Its depth is unknown. It has some peculiarities that render it worthy of particular attention. The water is continually in a great agitation, boiling like that in a pot over a fire, and with the same noise; yet, it discharges but a very small quantity of water, and that only once in a year. This happens, when the earth is filled with water by the vernal rains and melted snows, in the month of April or May. The water generally stands about a foot below the top of the rock; but it is frequently observed to rise and fall a few inches. When a quantity is taken out, it gradually recovers its height, and remains there nearly stationary.

There

There appears, at first view, some difficulty in accounting for the large discharge of air from this stagnant well. To remove it, I am disposed to believe that the water formerly flowing from it, which must have been considerable, has made itself a new vent. As soon as the stony concretion round this well, had risen to the height of the fountain from which it is supplied, the water could no longer overflow, but must force for itself another outlet. This it might do from the lower part of the well, which is pretty deep. In this case, while the water went off in its new course, the air it contained would naturally keep its direct ascent in the well. These suppositions are rendered more probable by two observable circumstances, viz. There are several small springs at no great distance from this well, that appear to be of a later date; and these springs do not discharge so much air as the others, in proportion to their water.

The appearance of the waters in all these wells, is nearly the same; being of a light milky colour, and in some of them a little turbid, by the particles of common earth kept suspended in them by their perpetual agitation. They are commonly covered in the morning with an azure tinctured film. Their taste is (apparently) acido saline, and much the same in all the springs mentioned. Though the taste itself is not pleasant, yet the impression which the water makes on the organs of taste, as it passes over them, is very lively, pungent, and agreeable; like that of good bottled beer or cider: and after drinking freely of them, I usually had eructations of the same pungent, stimulating gas, as is pro-

duced

duced by drinking those liquors. Unpleasant as their taste is at first, habit not only renders them tolerable; but to most persons very agreeable. Most of the invalids whom I sent to the waters, drank them after a short time with great avidity, to the amount of several gallons in a day: and some of the most intemperate of them assured me, with great seriousness, that they preferred them to any kind of spirits.

Having thus executed the first part of my plan, I shall next mention the experiments which I made on the waters. These, on account of the distance of the springs from the post where I was stationed, and the want of a proper chemical apparatus, were few and simple. They were sufficient, however, to determine the general impregnation of the waters, though not to ascertain the proportions of the combination in the several wells.

1st. A quantity of the water was evaporated to dryness by boiling; a greyish insipid powder remained, which produced a strong effervescence with the vitriolick acid, and appeared to be nothing but an impure calcareous earth.

2d. To some of the water I added a small proportion of the vitriolick acid; this occasioned a violent effervescence for a short time: after it had subsided, the water lost its natural milky hue, and became as transparent as common water; its acidity was increased; but not in proportion to the quantity of acid that had been added.

3d. I threw into the water a quantity of salt of tartar, which instantly dissolved without producing the least effervescence. The water, however, became immediately turbid and milky. On standing a few minutes, the milky sub-

Mo. Bot. Garden.
1897.

stance began to separate, and form into flocculi, which in a short time, settled at the bottom of the phial, leaving the water clear and transparent. Notwithstanding the quantity of salt of tartar was considerable, the taste of the water was not alkaline, though essentially altered.

4th. I moistened with the water some conserve of wild pinks (the only purple flower that I could find) but no change appeared that could indicate an acid: on the contrary, when I had wet some paper, previously stained with the same flower, the change of colour rather indicated an alkali. By wetting some of the same paper with a mixture of magnesia and water, the same change was produced.

These experiments were made on the water of the upper well: As that of the other two wells is not essentially different, it is needless to mention the result of the experiments made on them; nor was I very particular in making them.

5th. Observing the appearance of the matter deposited about the lowermost spring (which is a very small one, situated on the other side of the brook, discharging not more perhaps than a barrel of water in twenty four hours, and not before mentioned) and finding the taste of the water sweetish instead of acidulous, not unlike a dilute solution of sal. martis, I suspected that it contained a considerable portion of iron. To determine it, I boiled, for want of nutgalls, some shavings of white oak bark. The decoction was transparent, and of a reddish brown: to one part of this I added two parts of the water; the mixture became immediately of a dark brown, and lost its transparency.

From

From the experiments made on the water of the upper well, particularly from the first, it appears to contain a large quantity of calcareous earth; and from the same experiments, especially the second and third, it is probable, that this earth is suspended in the water by means of fixed air. From the ferruginous film with which these waters are often covered, it seems that they must contain some iron; though the proportion was so small, as not to be observed in the experiments which I made; but from the fifth experiment it is obvious, that the spring there mentioned is a strong chalybeate.

It is obvious that these waters are essentially the same with the acidulæ of Pyrmont, Seltzer, &c. which have so long been famous in Europe. The chemical analysis of those waters, and the experiments relative to the solubility of martial and calcareous earths in water, by the intervention of fixed air, made by Doctor Brownrigg and others, are so well known, it is unnecessary for me to give a particular explanation of the causes of the phenomena observed in the preceding experiments.

Notwithstanding these waters appear, by their chemical analysis, to be similar to the acidulous waters of Europe, they are probably much superiour to them in their medicinal virtue. That they are much more strongly impregnated, particularly with fixed air, is evident. The large quantity of calcareous substances found in these waters, must saturate much of it; yet so much of it remains unsaturated, as to give such a pungency to the water, that a quantity of it held in the mouth for a few seconds, burns it like ardent

spirits.

spirits. It is likewise well known, that these waters will burst any glass or earthen vessel, and force their way through any wooden cask, in which they are enclosed. This makes it impossible to transport them, in any considerable quantity, even the smallest distance, unless part of their fixed air be previously discharged. If they remain exposed to the atmosphere, the whole will soon be separated, after which they become dead and vapid.

Considering the vast quantity of fixed air contained in these waters, it is probable that the chalybeate is the strongest of the kind yet discovered. That it is highly impregnated, is evident by the taste. The fixed air, however, so far predominates, as to disguise, in a great measure, its disagreeable sweetness, and prevents its nauseating the stomach. How far the large quantity of saturated calcareous earth which they contain, may affect their medicinal properties, must be left to be determined by future observations.

The want of a proper apparatus put it out of my power to make such an analysis of the waters, as to determine in what proportion the several substances are combined with them in the several springs. There are also some other appearances, worthy the attention of a philosopher, which, for various reasons, I could not enter into an investigation of. It may afford an agreeable amusement to any gentleman of ability and leisure, to prosecute these inquiries. I sincerely wish, that some such would undertake the task; that the world may be favoured with a full and accurate account of these curiosities.

This

This analysis of these waters, imperfect as it is, may enable us to account for the formation of those stony substances which surround them. The fixable air, as it approaches the surface of the water, becomes elastick, and flies off: In consequence of this, the water assumes a milky hue, and some part of the calcareous earth is precipitated. To ascertain the truth of this supposition, I pulverized some of the stones (both of the porous and compact kind) in a mortar. They both appeared perfectly similar to the calcareous earth, procured by evaporating the water, and effervesced in like manner with the vitriolick acid.

From the large quantities of calcareous matter deposited round these wells, and the extent of ground rendered perfectly sterile by the overflowing of the waters, (for there is no kind of vegetation for many rods round on the lower side) I cannot but suppose, that these discharges of water have been much greater heretofore, than they are at present: for were they coeval with the earth, I can hardly conceive that the calcareous deposit from so small quantities of water, should have formed such masses; especially, when it is considered that all kinds of large quadrupeds are very fond of it, and that, 'till lately, this country has been well stocked with them. In effect, they have all the appearance of being in a state of decay. There is one of a small size, within six feet of the conical well, and nearly of the same form, which at present discharges neither air nor water, though it contains the latter, of the same quality with the others.

I will

I will here make the conjecture which I promised, respecting the cause of the rupture of the rocks near the upper well. That the apparent ruins are the product of some violent convulsion of the earth, cannot be doubted by those who have seen them: and that they could have been produced by an earthquake, the scene of whose immediate action lay at a distance, does not appear probable: the effects are evidently too great. The most reasonable supposition then seems to be, that however extensive the commotion might have been, which attended this explosion of the rocks, the cause of it must have been in the vicinity, and have operated immediately on this mass.

In searching after substances capable of producing such effects, the ledge of calcareous rock (already described) adjoining the springs, presents itself to our view. These rocks, called here lime rocks, are found in this part of the country in very large masses; and it is probable, that this ledge extends to a considerable distance below the surface. It is well known, that this lime rock contains a large portion of fixed air; that it is capable of being decomposed by acids, fire, &c. and that the subterranean regions abound with the vitriolick acid, where it unites with various bases, forming the vitriols, allum, &c. If we suppose a quantity of this rock, at a distance from the surface, decomposed by the vitriolick acid, or otherwise, and its fixed air rendered elastick, would not the force with which this air would endeavour to expand itself, be sufficient to produce such an explosion, as would burst asunder the most solid rock? The principal apertures would probably be immediately closed; but if the same

cause

cause continued to act, it must preserve some spiracula, where it found the least resistance: the explosion would have formed more or less of a cavity within the earth, and this cavity would naturally become a reservoir of water. This water, saturated with the fixed air, continually supplied by the decomposition of the rock, would be a proper menstruum for dissolving the calcareous earth, or iron ore, which it might meet with in its passage; and before its arrival at the surface of the earth, form the combination which we meet with in the springs. It is, however, but a conjecture; and one perhaps, that is not capable of being verified: as such, I submit it.

I shall now proceed to complete the execution of my plan, by giving a history of some cases, and the effect of the waters. In these, however, I cannot be very particular, as I had not the precaution to take any minutes.

It may be proper to premise, that these acidulous waters operate sensibly by vomit, stool, and urine. The first happens, only when they are taken on an empty stomach; and a pretty large quantity is necessary to produce the second. The last, therefore, is the evacuation which they must naturally excite.

The first patients that I sent were about thirty in number. Their disorders were rheumatick, scorbutick complaints, &c. with which old regiments generally abound. They almost all returned perfectly relieved, particularly the rheumatick patients. Indeed I am disposed to believe, as well from the accounts of the people in the vicinity, as from

my

my own observation, that in the chronick rheumatism, the waters are a very certain cure.

Among these patients was one, whose case deserves a more particular description. He was a man of about twenty four years of age, of a slender habit, and delicate constitution. He had not been fit for duty much above half the time, for the two years he had served in the regiment; and for five or six months, had been troubled with scrophulous and pulmonick complaints, a pain in his breast, cough, and sometimes a slight hæmoptysis. At this time he had a hectick fever; and I suspected that he had tubercles formed in his lungs, which were about suppurating.

I sent him to the springs in the month of April. By drinking the acidulous water about a fortnight, his symptoms were so far removed, that he has enjoyed tolerable health, and has done his duty in the corps ever since, excepting that very lately he felt some symptoms of his old disorders, which were soon removed by returning to the waters.

I had afterwards two patients, whose livers were left greatly tumefied, indurated, and painful, by an obstinate jaundice; on which the common deobstruents had little or no effect. I sent them to the springs for relief; and within a week they returned perfectly cured.

A girl belonging to Albany, in consequence of a fall on the ice, above two years before, had seven or eight sores broke out on the whole length of her left thigh, which in time became ulcerous. By the advice of Doctor Young, who had very faithfully attended her, she was carried to the

springs.

springs. On her way she stopped at the garrison, and I saw her. All the muscles of her thigh were useless; and her knee consequently, destitute of any voluntary motion. Her leg was drawn backwards, and fixed: her thigh was considerably enlarged, and in places, very hard: the ulcers had a foul and angry appearance; and at times she suffered considerable pain. After she had used the waters a fortnight, she returned, and I saw her again. The swelling and induration were removed; her pains were much abated; her knee was more flexible; and her ulcers had assumed a favourable appearance. It is not supposable that in such a case, any course of internal medicines could effect a cure: but, I believe that so much could not have been done towards it, in the same time, by the best medicines of the shops, though ever so judiciously administered; nor, perhaps, in a much longer.

Many people in the vicinity, suppose the waters a cure for intermitting fevers; and when properly used, I have no doubt but that they may be. For this purpose, after using the acidulous waters a few days, recourse must be had to the tonick virtues of the chalybeate. But for want of proper directions, I believe this has not been practised. The advantages derived from them, therefore, were the same that are produced by evacuations, and small doses of tartar emetick, by which the fits may very often be broken, and the disorder sometimes removed. I have made trial of them in but one case of this disorder; and that was before I had discovered the properties of the different springs. The patient

 used

used the acidulæ alone; and was only well prepared by them for the use of the bark.

As a practical proof of the tonick power of the chalybeate waters, I might mention the case of a woman whom I found at the springs. She complained, that the acidulous waters (of which alone she had drank for several weeks) reduced her strength. From a persuasion of the astringency of the chalybeate spring, I advised her to drink a moderate quantity of it, for a day or two, and to repeat it occasionally. I saw her again some time after, when she informed me that she had followed my advice, and always found from it, a remarkable restoration of strength.

These are all the cases that are worth mentioning, in which the good effects of the waters were evident; though perhaps, eighty patients belonging to the regiment may have used them successfully, most of their complaints being of little consequence.

I must not however, omit one case, in which the success attending the use of the waters answered neither my wishes, nor my expectations. An officer in the regiment, a little past the meridian of life, had been for many years, troubled with a tetterous eruption, on different parts of his body. It gave him no great uneasiness, 'till the summer of the year 1780, when it fixed on one of his ankles. Notwithstanding many topical applications, it daily gained ground; and the latter end of the year 1781, after an active campaign, had possessed that whole leg, and part of the other. The disorder would sometimes alternate with his stomach and bowels, producing severe pains, with a copious discharge of foul

matter

matter by vomit, and sometimes by stool. The eruption was removed from his legs by a very ingenious surgeon in the American hospital. His stomach was, however, frequently disordered afterwards; and he was, perhaps, on the whole, not much better for the removal of the disease from the surface. During the last winter, his stomach and bowels were frequently much affected; and though his appetite was generally good, yet his digestion was impaired, and few kinds of food would remain on his stomach. Evacuations, with the bark and bitters, yielded a temporary relief; but produced no permanent advantage.

In this situation he resolved, about the middle of April, to try the effect of the springs. From the accounts I had received (for I had not then seen them) I approved of his plan; and he immediately proceeded to execute it. After using the acidulous waters for twelve or fifteen days, he returned to quarters, surprisingly reduced; complaining that "they had torn his stomach all to pieces."

As soon as he had recovered strength enough to ride, he retired from service, and I have not heard from him since. I apprehend that he used the waters imprudently, and that if he had made a judicious use of the two different kinds, he might have found that assistance from them, which he had in vain sought from other medicines. He is fully of this opinion himself; and ascribes their failure to his drinking them in pretty large quantities, when his stomach was too weak to bear them.

I beg leave to subjoin two or three general remarks on the virtues of these waters. From the cases related, I think we

may

may conclude, that the acidulous waters possess considerable aperient or deobstruent powers, and may therefore, be useful in most kinds of obstructions. That they share the refrigerant and sedative properties of the acids, cannot be disputed. By these they are well calculated to remove that inflammatory diathesis, which usually accompanies so many disorders, and embarrasses the physician in his prescriptions.

Among the rest, do they not promise to be serviceable in removing that obstinate, though sometimes small, inflammation of the lungs, which so often terminates in a phthisis pulmonalis and death? I think their success in the pulmonick case above related, some proof of it.

The chalybeate water may, without doubt, be an excellent remedy in all cases of simple relaxation, or where that is the primary disorder; and is always at hand to brace up, and invigorate those patients, who are debilitated by the use of the acidulous.

These are a few of the obvious medicinal virtues of these curious springs. But, perhaps, nothing but a series of accurate observations by ingenious practitioners, can determine all their properties and excellencies.

I am, &c.

SAMUEL TENNEY.

DR. FISHER.

P. S. Five months after writing the above, I saw the officer whose case is there related. He informed me, that he got home with difficulty, and for some time declined so fast, that he despaired of recovering. At length, however, his constitution, naturally vigorous, prevailed over his disorder: his strength was restored: for several months he had been

entirely

entirely free from any symptoms of his former complaints; and had enjoyed a better state of health than he had for several years before. As he used little or no medicine after drinking the waters, I think we may justly conclude that the acrimony, which for two years had rendered his life miserable, was eradicated by them alone. The pulmonick patient likewise, whose case is there mentioned, continued in good health.

S. TENNEY.

DR. JOSHUA FISHER, F. A. A.

III. *Conjectures of the Natural Causes of the North West Winds being Colder, and more frequent in the Winter in New England, than in the same Degrees of Latitude in Europe, by* SAMUEL HALE, *Esq. of Portsmouth*, F. A. A.

THE attraction of the Moon and Sun makes the current of air and water, on the globe, move continually towards the west, between the tropicks; unless where obstructed by land, high mountains, &c. which causes an eddy, both in the air and water, in a contrary course beyond the tropicks. And we actually find the gulf stream to be a very strong current, reaching from Cape Florida, along the shore, at unequal distances therefrom, to the Isle of Sable, and Grand Bank. And it is highly probable, that the sand carried by this stream, together with the sand carried down by great rivers into bays, and the current out of those bays meeting with the gulf stream, by their eddies, have made Nantucket Shoals, Cape Cod, George's Bank, Cape Sable Bank, the Isle of Sable, &c. But to return: the wind, which being mostly westerly beyond the tropicks, as an eddy to the tradewind, by passing along upon the tops of the

Appalachian, Allegany, and other high mountains, which form a long ridge, back of our settlements, must be made very cold; or, if the wind should come from the north or northeast on to those mountains, the effect would be the same: For we know, that the snow lies through the summer, upon the tops of very high mountains, such as the Andes, the Alps, Ætna, &c. Now, the course of the sea being N. E. and S. W. and the air being made warmer, and consequently lighter, upon the coast, in the winter, than it is upon and near those mountains, this causes a current of air, at right angles with the coast of the sea, that is, a N. W. wind, which coming down from the tops of the mountains, with the increased cold it there contracted, occasions our north west winds to be more constant in the winter, and colder than in other parts of the world, in the same latitude, not so situated. This will also account for the N. W. wind being often colder, and the thermometer lower in Connecticut than in Nova Scotia; although the latter be so much further north; as the wind comes down from the tops of higher mountains upon Connecticut. Upon the same principles, our S. W. winds, coming along on the south east side of the ridge of mountains, and not over them, will be warm. This will also make it probable, that the N. W. winds are not so cold on the low lands N. W. of those mountains, as in the same latitudes on the S. E. side; and the weather, in general, milder. The great lakes N. W. from us never freeze; and if they did, their ice, when covered with snow, could not affect the air over them, any more than land covered with snow: so that the great lakes, back of us, being heretofore given as the reason of N. W. winds being so very cold, must

have

have been a mistake. We can hardly suppose a N. W. wind, coming from the N. W. corner of this continent, without altering its course, to be the cause; if so, why are not the N. E. winds in Europe and Asia, in the same latitudes, as cold? — But we find they are not.

IV. *An Account of Frogs found in the Earth; in a Letter to the Reverend* NEHEMIAH WILLIAMS, *by Major* SAMUEL HITCHCOCK.

Brimfield, August 5, 1789.

SIR,

THE following extract of a letter was written me some time since, by Major Samuel Hitchcock; but by mistake, is but just come to hand. The letter was dated at Manchester, Vermont, November 27th, 1788. The account, contained in this letter, has since been confirmed to me by another gentleman, with this alteration, that the house must be as much as forty or fifty rods from the river.

"I leave this place, for Burlington on Onion river, in three or four days, where I expect to reside in future. It is handsomely situated on Lake Champlain, and on a very pleasant river. I was informed by a gentleman in that town, of a curiosity, which I cannot forbear mentioning to you.

"A gentleman of undoubted veracity, who lives about twelve or fifteen rods from the river side, informed me, that he had lately been digging a well by his house, about the same distance from the river. The house is situated on a little eminence, or rise, that overlooks the river and interval adjoining it; which, previous to his clearing it, was covered with a large growth of timber. The stumps appear to be two feet, two and an half, and three feet thick. At about

twenty

twenty or twenty five feet deep, the diggers discovered some small frogs, which appeared to adhere closely to the earth, and perfectly stupified and dead. They threw them out of the well; and when they were exposed to the heat of the sun, in a short time, they appeared to vivify; and soon became full of life and activity. As they still dug deeper, they discovered more of them; which exhibited the same phenomena. My informant told me, that he was himself a witness to as many as twenty or thirty of them.

"At about forty feet depth, they came upon a large stump, at the root of which they discovered a fine spring of water. He showed me a piece of the stump: it resembled button wood. I was particular in my inquiry, whether there were no avenues, or cavities in the earth, leading or communicating with the river; through which the frogs might have passed? He informed me, none; nor any appearance of water. How long those animals must have remained there, it is impossible to determine; but in all probability, they must have been in that inactive state, some hundred years. From the discovery of the stump, it is evident, that the land must have been made land. I conclude, that in some inundation of the river, those animals must have been covered up; and there remained ever since."

I have nothing to add; but only, from the information that I have received, I cannot question the truth of the above account, however extraordinary it appears.

I have the honour to be,

Your most obedient, and

very humble servant,

NEHEMIAH WILLIAMS.

Caleb Gannett, *Esq. Recording Secretary*, &c.

V. *An Estimate of the Excess of the Heat and Cold of the American Atmosphere beyond the European, in the same parallel of Latitude: To which are added, some Thoughts on the Causes of this Excess, by* EDWARD A. HOLYOKE, M. D. F. A. A.

PART I.

ALMOST from the first discovery of North America, it has been observed, that the extremes of heat and cold are much greater on this side the Atlantick Ocean, than they are in Europe, under the same parallel of latitude. But the quantity of this difference has not hitherto, so far as I am acquainted, been an object of much attention, or been determined with any degree of exactness. A valuable work, annually published for some years past, by a Meteorological Society at Manheim in Germany, entitled *Ephemerides Meteorologicæ Palatinæ,* affords data for determining this point more precisely; as it contains more numerous and more accurate observations, than any other publication extant.

I have therefore, from this collection, formed a table of the greatest heat and greatest cold, and of the mean of the greatest heat and cold, for a course of years, of twenty different cities in Europe; the southernmost of which is Rome, in lat. 41° 53′, a few minutes southward of Boston; and the northernmost, Stockholm, the capital of Sweden, in lat. 59° 20′, comprehending an extent of upwards of 17° of latitude; and from Rochelle, on the western coast of France, to Buda, the capital of Hungary, comprehending 20° of longitude; which takes in all the middle region of

Europe. To which are added my own observations of the greatest heat and cold, &c. made at Salem in Massachusetts.

By this table it appears, that of the twenty European cities, mentioned in it, the thermometer was highest at Wartzburg, in the circle of Franconia, viz. 102°. 4, which falls short of our greatest heat above 3 degrees. The greatest degree of cold happened at Sagan, a city in the western borders of Silesia. There the mercury in the thermometer sank to — 21°. 32, which exceeds our greatest cold at Salem by 10°. 3; but is just as low, as we were informed by the publick prints at the time, though I know not upon what authority, that the thermometer fell at Hartford in Connecticut, and at New York, in the month of January 1786. But what is most to our purpose, the *mean* of the greatest heat in all those places, taken collectively, for the period noted in the third column of the table, amounted to no more than + 86°. 41, which is more than 10° short of the mean of our greatest heat at Salem: and the mean of the greatest cold in these twenty cities, amounted to + 3°. 31, which is short of the mean of our greatest cold upwards of 5 degrees.

But in order to determine the difference between our heat and cold, and the European, in the same latitude, we must compare with those cities, which are situated in latitudes nearest our own, viz. Padua, Marseilles, and Rome. We find by the table, that the mean of their greatest heat falls short of our's 5°. 62, 7°. 42, and 11°. 59, respectively. We also find the mean of the greatest cold of these three cities is less than our's by 19°. 41, 29°. 92, and 35°. 88, respectively. Further, the mean of the greatest heat of these three cities,

taken

taken collectively, which is 88°. 1, deducted from the mean of our greatest heat, which is 97°. 02, leaves a difference of 8°. 92 hotter. And the mean of the greatest cold of these cities, being + 25°. 96, taken from the mean of our greatest cold, — 2°. 42, gives a difference of 28°. 38 colder.

The air of America then, in our latitude, is hotter in summer (when hottest) by 10 degrees of Fahrenheit's thermometer*, and colder in winter (when coldest) by 5 degrees, than the whole middle region of Europe taken collectively, whose mean latitude is about 49° or 50°, that is, about 7 or 8 degrees more northerly than Boston.

Again, the air of America is hotter in summer, by upwards of 8 degrees, and colder in winter, by 28 degrees, than those parts of Europe, which lie nearly in the same latitude.†

PART II.

HERE then is a very notable difference in respect both of heat and cold, in two tracts of our globe, which equally enjoy the influence of the sun, that prime source of heat to our system; and it is much greater, I believe, than any one would imagine, who had not attended to observations of this kind: which naturally leads to an inquiry into the cause of so remarkable an excess; for this cause still remains

* I have all along made use of Fahrenheit's scale, as being much more familiar to us than Reaumur's.

† As these three cities, taken together, lie a degree or two northward of us, the result here given is rather less, than the true.

mains a problem, which has never, I suppose, received a satisfactory solution.

Various conjectures have been formed upon the subject; one or two of which I will mention. The first, and perhaps, the most commonly received opinion among us, is, "That those lakes and large tracts of inland waters, which lie back of our settlements, being constantly frozen over every winter, expose a large surface of ice to the air; which being hereby rendered very cold, and being soon wafted to the sea-coast, where our most numerous settlements are situated, occasions that degree of cold, which the inhabitants of North America suffer beyond the Europeans in the same climate." To which I object, 1st. That the winds, which for the most part produce our most intense cold, are not westerly, as upon this hypothesis they ought to be, but north westerly, or still more northerly winds, which last certainly do not blow over any great extent of water in their passage to our coasts. 2d. The cause assigned does not seem adequate to the effect; for, though the lakes to the westward of us are large, yet they bear but a small proportion to the extent of land, over which the winds must pass, ere they arrive at our settlements. 3d. I suppose that a surface of frozen water does not render the air, that passes over it, in any degree colder, than an equal surface of frozen earth; for frozen earth is as cold as frozen water; and all the surface of the ground, between the lakes and us, is frozen every winter, before the lakes themselves are. And, if they do not render the air colder, after they are frozen, than an equal surface of frozen earth; certainly it cannot

be

be supposed that they increase the cold, before that period. Add to this, 4th. That this surface of ice, which covers the lakes every winter, is pretty early in the season clothed with snow, more or less deep, as well as the whole surface of these northern countries: Now, no one can suppose that snow, because it lies upon a surface of water or ice, is capable of producing a greater degree of cold in the atmosphere, than if it covered an equal extent of ground. These observations do, I think, evidently shew, that this hypothesis is not admissible.

Others have supposed, "that our woods and thick forests, by harbouring large quantities of snow every winter, and screening it from the action of the sun's rays, do occasion the air, which blows over it, to be much colder, than it would be otherwise, or than it is in Europe." This may indeed in some measure account for the length of our winters, and the sharpness of the winds in the spring; as the snow will remain longer undissolved, when shaded from the sun, than in the open and cultivated parts of the country: But, I do not conceive how the snow, which lies in the woods, should communicate any extraordinary keenness to the air, beyond that which covers the ground every where in these regions, whether cleared or uncleared, during the winter season.

However, that the woods of America are somehow the occasion of its greater cold, must, I believe, be admitted.

Several writers have observed, that the winter's cold in the old continent was formerly much more severe and intense in the same climate, and the same spot, than it is at this day.

This

This is a remarkable fact, of which, however, I imagine there is sufficient proof. For severe frosts are mentioned by ancient authors, as common events, in particular places, where nothing of the kind occurs now; or, if at some distant intervals they do still sometimes happen, they are constantly noted as very extraordinary.

David, king of Israel, in one of his psalms* says, "He giveth snow like wool, he scattereth the hoar frost like ashes. He casteth forth his ice like morsels; who can stand before his cold?" And about the time of our Saviour's crucifixion (about the beginning of April) St. John tells us†, that "the servants and officers had made a fire of coals (for it was cold) and they warmed themselves."

And Juvenal makes mention of the freezing of the river Tiber, as a common event in his time.‡ And Ovid talks of frozen wine in countries, where I suppose, very severe frosts are now very unusual.§

If any doubt respecting this point should still remain, I believe it will be much lessened by an attention to what Livy the Roman historian relates, in his account of the second Punick war. There we find, that when the Romans, under the command of Scipio, besieged a town in Spain near the river Ebro, in a latitude a little more southward than our's, he says, "*Nec obsessor alia ulla res quàm iniqua oppugnantibus*

* Psalm cxlvii. v. 16, 17. It is not material whether David were the author of this psalm, or not.

† John, ch. xviii. v. 18.

‡ Hybernum fracta glacie descendit in amnem. &c. Sat. vi. l. 521.

§ Nudaque consistunt formam servantia testæ
Vina: nec hausta meri, sed data frustra bibunt. Eleg. x.

nantibus hyems tutabatur. Triginta dies obsidio fuit, per quos raro unquam nix minus quatuor pedes alta jacuit: adeoque pluteos ac vineas Romanorum operuerat, ut ea sola ignibus aliquoties conjectis ab hoste, etiam tutamentum fuerit." (Lib. xxi.) That snow should lie four feet deep on the ground for thirty days together at Taragona or Barcelona (in the neighbourhood of which this town lay) would at the present day, be looked on as a most extraordinary phenomenon indeed. See also Virgil's 3d Georgic.

And, as no change has taken place upon the surface of the earth in that continent, that we are acquainted with, so remarkable, and so likely to have any great influence upon the atmosphere, as that of cutting down and clearing the earth's surface of those woods and thick forests, that abounded every where; may we not probably conjecture that this circumstance is somehow the cause, why it is warmer at Palestine now, than in the days of king David; and at Rome, than it was in the times of the commonwealth, or of the Cæsars ?||

Now, it appears highly probable, that the same cause, whatever it was, which rendered Europe colder formerly, than at present, makes America at this day colder, than Europe. America is at this day, in a situation similar to that, which Europe was in, with respect to its woods, thirty or perhaps

|| It appears by the annexed table, that at Rome there does not happen every year, at this day, such a degree of cold, as to sink the thermometer down to the freezing point. The difference then between its atmosphere in Juvenal's day, and the present, must be very great. And, as to Jerusalem, as it lies about 10 degrees further south than Rome; I presume that nothing like a frost ever happens there, at this day.

perhaps thirty five centuries ago. Its surface, excepting about a hundred or a hundred and fifty miles, more or less, along the sea coast, is almost universally covered with thick, and almost impenetrable forests, as is well known to every one. And, as the same causes always produce the same effects, it seems very probable, that the forests of America, are in some way or other, instrumental in producing that extra degree of cold, for which our winters are so remarkable.

Taking this therefore for a probable supposition, let us pursue it, and inquire whether it be confirmed by reason and experiment.

Among the many happy discoveries in philosophy and chemistry, with which the celebrated Dr. Priestley has obliged the world, one of very great importance is; "the property, which the leaves of all plants and vegetables of every kind possess, of yielding, in day light, air of a much purer kind, freer from phlogiston, and fitter for respiration, than common atmospherick air: that they not only furnish large quantities of such air, but have also the faculty of absorbing phlogiston from air, when fouled by a mixture of it, so as to render the same salubrious and respirable, which was before noxious and suffocating; and thus become, in the hands of the great Author of Nature, one grand corrector of those impurities, which might, otherwise, so far increase, as to contaminate the whole mass of the atmosphere, and in process of time render it totally unfit for respiration, and the support of animal life." This is a doctrine well established, and needs no new proofs.

All

All vegetables then, both in Europe and America, are continually supplying the atmosphere with this pure air, and counteracting those phlogisticating processes, such as combustion, respiration, putrefaction, &c. which are continually going on in all parts. But there is this material difference between the two continents. In Europe, upon the coming on of the frosty season, the leaves of all vegetables, on or near the earth's surface, languish; and, if they do not die, yet most probably they perform their office of dephlogisticating the air, in a much more languid manner, than in summer; or are perhaps entirely covered with snow, which, while it continues on them, must effectually put a stop to this process; and as to the trees, their leaves for the most part drop off, and no more pure air is to be expected from them, till they are again renewed in the spring. But in America, although the leaves of all vegetables on the earth's surface are frozen and killed early in the winter, and the leaves of many of our trees fall off, and yield no more of this pure air, than the European trees; yet, there is a constant and large supply of it, from those vast quantities of pine trees, firs, spruce, cedars, junipers, savins, hemlocks, and other ever-greens, which retain their leaves through the intensest frosts, and which do greatly abound in our American woods, from the 30th to the 50th degree of N. latitude; a quantity sufficient, perhaps, to cover one 5th or 6th of the whole surface of the continent of Europe.

That our evergreens do in fact yield, during the winter season, such a pure air, I have several times found by experiment. My experiments were conducted in the manner,

in which Drs. Priestley and Ingenousz conducted their's; and I constantly found air produced from the leaves of juniper and pine (the only ones I have yet made trial of) in the same manner, as from other leaves in summer.* But it ought to be observed, that this manner of experimenting cannot be prosecuted, when the water is colder than 32 degrees by Fahrenheit's thermometer, as the water would then be converted into ice; but it appears reasonable to suppose, if as much air is produced in these experiments, when the thermometer is at 34° or 35°, as when it mounts to 70° or 80°, that the weather, though much colder, would make no material alteration in the result. This fact then is not to be considered as fully established (though I believe, whenever proper and decisive experiments are made, it will be confirmed) but as in a good degree probable.

This being allowed, what a fund of pure dephlogisticated air have we here in America, beyond what Europe at present possesses. There are no doubt evergreens of various kinds scattered all over Europe; yet it cannot be supposed, that the quantities bear any proportion to those, which once flourished there; especially in the southern and middle regions of that continent; and as to Scandinavia, where I sup-

pose

* I have not yet had either time or opportunity, to prosecute experiments upon evergreens, as I could wish, or as I promise myself I may have; but, from what I have experienced, I think it no extravagant supposition, that a pine tree of a common size should yield four barrels of pure dephlogisticated air in one clear fair day; to which, if we add that as much phlogiston is absorbed in the same time, as an equal quantity of common atmospherick air contains; we may readily imagine, that, in a country abounding with trees of this kind, the atmosphere must be much more dephlogisticated in winter, than in a country, where evergreens are rarely met with.

pose they abound most at present, I imagine they must be very much thinned by this time. But what will all these amount to, when brought into a comparison with the evergreens of America?

From these considerations I think it must appear highly probable, that America is furnished with sources of dephlogisticated air, which are now exhausted in Europe; and that therefore, most probably, its atmosphere is really more pure and dephlogisticated.

Whether this be in reality the fact, may be determined most satisfactorily from meteorological observations. For the sensible qualities of the atmosphere, which are the objects of meteorology, may, if properly attended to, and noted down for a course of years, determine not only which country enjoys the dryest and purest air; but also the quantity of the difference (if any there be) may as easily and as precisely be known, as the difference of their heat and cold.

To such observations then we must recur; and, if we are enabled to determine—the quantity of evaporation—the quantity of rain—the number of clear fair days—the number of cloudy days—of rainy days—and of foggy days, in each continent, for a competent course of years, there is no doubt but the point may be satisfactorily determined. This I shall next attempt; after premising that we have not yet, perhaps, observations enough to settle the matter without all doubt; yet enough, I imagine, to shew that it is in the highest degree probable, that the climate of America is much drier in general, than that of Europe.* The

* Perhaps the most direct way of determining the dryness of the atmosphere is by the hygrometer; but till this instrument is more improved than at present, and observations

The quantity of evaporation in any country must, I think, depend principally, if not entirely, upon the three circumstances of—dryness—heat—and motion, of the air, contiguous to the evaporating surface.* For the dryer the air, the more capable it is of absorbing a certain quantity of water in a given time; for when fully saturated with water, as in a foggy season, little or no evaporation takes place. Heat too is found to promote evaporation, probably as it lessens the cohesion of the particles of water: and the wind, not only by agitating the evaporating surface, but also by applying fresh portions of air to the same, tends greatly to promote this process.

Now, all these circumstances conspire with us in America, in a greater degree than in Europe, to increase the dryness upon the surface of the earth. And such a degree of dryness does in fact take place here, as much more frequently to injure our crops, and frustrate the hopes of the husbandman, than in Europe.

The proof of this point however, from actual observation, according to the *Ephemerides Meteorologicæ*, is rather lame; for of the six or seven places mentioned in that work, which can be easily brought into a comparison with those of Dr. Williams in the same work, which are the only American ones, which I have met with, two, if I understand them, exceed his considerably: all the rest indeed fall much short;

servations have been made upon it for some competent time in both continents; this mode of determining it must remain a desideratum.

* Electricity may perhaps be considered as another cause promotive of evaporation; but then I suppose it probable, that its effect in promoting evaporation, may be very much in proportion to the dryness of the atmosphere.

short; for the mean evaporation of those seven places does not amount to quite 45 inches, for the year 1785; whereas the evaporation at Cambridge the same year, by Dr. Williams' account, was upwards of 56 inches.

The great difference in the quantity of rain, which falls in different countries annually, makes this a remarkable article in the meteorological register. We are informed by Dr. Lind,* that at Senegal in Africa there falls, in the four rainy months, 115 inches depth of rain; and by the Ephemerides so often quoted, that at St. Petersburg, in Russia, in the year 1785, there fell short of 12 inches.† Now I think it almost certain, that the quantity of rain, that falls yearly in any country, provided it be sufficient for the purposes of vegetation, must be very much in proportion to the annual quantity of evaporation, in the same region. For a very trifling quantity would any where be enough, if none of it were to pass off by evaporation; as, on the other hand, scarcely any assignable quantity would be sufficient, if the whole of it were suddenly exhaled. The drier the air is then, in any large extent of country, the more rain is required to support vegetation in its full vigour. So that the comparative dryness of the atmosphere, in any two countries, may be pretty fairly inferred from the annual quantity of rain, which falls in each of those countries respectively, for a course of years; provided vegetation be equally vigorous in both.

From

* Diseases of hot climates.

† And we are not informed that this year was remarkably dry there.

From the many registers, which have been published of the depth of rain, which falls in a great number of places in Europe, and for a long course of years, it appears, that the medium quantity of rain in that quarter of the globe scarcely equals, but certainly does not exceed, 30 inches from year to year. But in America, viz. at Ipswich-Hamlet, by the observations of the Rev. Mr. Cutler, upon a mean of five years (the last of which, viz. 1787, was rather a dry one) there fell inches 49. 472. And by Dr. William's observations at Cambridge, there fell in 1785, inches 47. 616.—And by the observations of the Rev. Mr. French at Andover, there fell there, on a mean of the seven last years, inches 51. 2. annually.

The number of fair unclouded days, which happen in the course of a year, for several years together, in any place, must also give some indication of the dryness of the atmosphere of that country; for, as clouds are formed from the moisture existing in the air, a freedom from them must indicate a deficiency of moisture; that is, the air must be drier. Now it appears from the Ephemerides Meteorologicæ Palatinæ, that the mean number of fair days, by observations made in twenty different cities in different parts of Europe,* amounted only to sixty three, or sixty four, and that the same year at Cambridge there were one hundred and seventy three such days. To which I may add, that by my own observations at Salem, upon a mean of seven years, we had one hundred and thirty fair days annually.

The

* Viz. Those mentioned in the annexed table.

The number of cloudy days in these same twenty cities was in 1785, upon a mean, one hundred and thirteen, or one hundred and fourteen; but at Cambridge there were only sixty nine; and at Salem, upon a mean of seven years, about ninety five days annually.

The number of days, which were partly cloudy, in those same cities was one hundred and seventy four, or one hundred and seventy five; at Cambridge but one hundred and twenty three; and at Salem annually, for seven years, one hundred and twenty upon a mean.

The number of rainy days in those cities was upon a mean 122; at Cambridge only 88; and at Salem 95 annually, for seven years.

The number of foggy days in those cities was sixty seven; at Cambridge sixteen; and at Salem, for seven years, twenty one days annually.

As to hygrometrical observations, we unluckily have none to compare with the European ones; excepting only those made by the illustrious Dr. Franklin, and communicated in a letter to Mr. Nairne on hygrometers, published in the 2d. vol. of the Transactions of the American Philosophical Society at Philadelphia; by which it appears, that the air of Philadelphia is drier, not only than that of Great Britain, but also than that of Passy, in France. This evidence seems to be direct.

Our evaporation then is greater, than the European; our quantity of rain, much greater: we have more clear fair

days;

days; we have fewer cloudy days; and fewer foggy days; and fewer rainy days.*

Thus, by every method of comparing the two atmospheres, the American appears to exceed the European in point of dryness. And, although perhaps no one of all these facts, brought to prove our atmosphere drier than that of Europe, does, when taken singly, determine any thing very satisfactory; yet, when they are all fairly and candidly laid together, the proof arising from their joint evidence amounts to a very high degree of probability.

It may now perhaps be thought incumbent upon me, to shew how a greater purity and dryness of the atmosphere, should occasion greater degrees of cold, or heat; or that I should point out the process of Nature in generating heat or cold from dryness and dephlogistication.† And many probable reasons drawn from chemistry, and many very plausible conjectures might be adduced, to prove and illustrate this point. But, as it seems generally supposed, that all the theories of heat, hitherto proposed, are rather imperfect; or, however that may be, as I must freely confess my-

self

* In the summer season, as there are more phlogisticating processes going on in Europe, to render the air foul, than in America, such as combustion, respiration, putrefaction, &c. so in the latter it is probable, that, at this season, the vast number of trees, in addition to the vegetables, which grow nearer to the earth's surface, in as great plenty as in Europe, must furnish a larger proportion of this purer air: so that in the hot as well as the cold seasons of the year, America must have the advantage of Europe in this particular.

† I have used the terms *dry*, *pure*, and *dephlogisticated*, as synonymous, or at least have considered them, as qualities accompanying each other in the same state of the atmosphere. But, that they are always necessarily and physically connected I do not pretend to assert; that they commonly do accompany each other, I believe to be certain.

self too little acquainted with its nature, to enter upon such a discussion, I would rather refer to observation and experiment.

Now it is, I believe, matter of constant and universal experience, at least in this country, and I suppose every where in cold countries, that the most intense cold always happens in the purest, driest, and most dephlogisticated state of the atmosphere; or, that we never have our intensest frost, but when the air is in this state. That the air is very dry at such times, appears from the shrinking of wood, and all vegetable and animal substances, &c. That it is in a dephlogisticated state, appears from the rapid consumption of fuel, and the great tendency to scorch observable at such times in our ordinary fires; from the increased brightness and magnitude of the flame of candles and lamps; and from many other circumstances, which might be mentioned. The weather indeed is frequently raw cold, as we vulgarly phrase it, and excessively uncomfortable, when the atmosphere is in a very humid state. The most disagreeably cold weather, which we have in winter, happens, when the air is in this damp state; but the thermometer at such times is never at, or near its lowest stations; perhaps never nearer, than 15 degrees or upwards.

Further, although the weather is frequently, during summer, most disagreeably hot and irksome to our feelings, when the air is very damp and phlogisticated, as appears by effects directly opposite to those just now enumerated, as the consequences of dephlogistication; yet, so far as my observa-

tion reaches, the thermometer is never at its highest, at such times, but commonly 6 or 8 degrees below it.*

Whence I think it may fairly be inferred (whether we are able to account for it philosophically or not) that dryness or dephlogistication, are in fact and nature, necessary to the production of our intensest cold ; and probably of our intensest heat. And if so, is it not natural to suppose, that when the atmosphere of any country is usually both in summer and winter much dryer, and more dephlogisticated, than another, that, cæteris paribus, it should be hotter in summer, and colder in winter there, than in that other?

But, allowing all that has hitherto been advanced upon this subject, I would not hastily conclude, that the superiour dryness and dephlogistication of our atmosphere is alone sufficient to account for the whole of our superiour heat and cold. There are probably other causes, which conspire with it to produce the same effect. I shall mention one, which I think of considerable moment.

All

* It may perhaps, have the appearance of paradox, to ascribe two such opposite effects, as heat and cold, to the same cause; but this appearance will in a good measure vanish, if it should be found, as I suppose it may, that dephlogistication produces cold, by its *chemical* effect upon the air: But that it produces heat only *mechanically*, by inducing a more perfectly pellucid state of the atmosphere, whereby fewer of the sun's rays are intercepted; and (as dephlogisticated air is specifically heavier by much, than common atmospherick air) by occasioning a greater weight and density of the air, near the earth's surface, whereby the sun's influence in producing heat is greatly increased. These considerations may serve to shew, why cold is so much more increased, by a dephlogisticated state of the atmosphere than heat. And it is observable, that the difference between two thermometers, one of which is exposed to the sun's direct rays, and the other in the shade, is always, cæteris paribus, much greater in a dephlogisticated, than in a phlogisticated state of the atmosphere.

All coasts, which border upon a large ocean, in cold climates, must, during the season of winter, be warmed by winds which blow from the ocean upon them; plainly for this reason, that the waters of the sea in those latitudes never become so cold by many degrees, as the surface of the earth: so likewise, in those same regions, the water of the sea never becomes, during the summer, so warm as the earth's surface; and therefore, at this season, winds blowing from the sea upon the land, cool the air.

Now, it appears by the Ephemerides Meteorologicæ Palatinæ, that the winds, which are most prevalent in Europe, blow from the West, or at least from that semicircle of the horizon; more especially during the summer and winter months. Westerly winds then, must cause the air of Europe to be warmer in winter, and colder in summer, than those that blow from the opposite quarter; because that continent lies eastward of the great Atlantick ocean. The directly opposite effect takes place in North America, from the same cause; that is to say, the winds, which prevail most with us, particularly in the hot and cold seasons, are likewise from the western quarter; for in the vernal and autumnal seasons, they are commonly more variable, and blow more frequently from the eastward, than in summer or winter.* We therefore, feel less of the warming effects of the sea air in winter, as well as less of its cooling ones in summer; because

* Upon examining a number of American meteorological registers for a course of several years, I do not find more than one month in sixteen or eighteen, in which easterly winds predominate; but I find seven or eight in a year upon an average, in which they blow almost constantly from the westward.

cause our coasts lie westward of the ocean. Thus, the winds which prevail most in Europe, tend to mitigate both the heat and the cold, to which its geographical situation exposes it; as, on the contrary, the same winds increase both the cold of winter and heat of summer, on the American coasts.*

But upon the supposition, that westerly winds are most prevalent in the middle latitudes all round the globe, which seems rather a probable conjecture, if we consider the facts just mentioned; and further, that the course of the trade winds in the torrid zone is continually from the eastward; it ought to follow, that the eastern coast of Asia, as well as the eastern coast of America, should be colder, than the western coast of Europe, or than the western coast of America, under the same parallel. And that such a difference does really obtain, seems to appear from the account given by the writer of Captain Cook's last voyage, who informs us that vegetation was in great forwardness in the month of April, at Nootka or King George's Sound, on the western side of N. America, in the latitude 49° 36′ N. in the year 1778: Whereas the next year, at the bay of Awatska, in Kamtschatka, on the eastern coast of Asia, in lat. 53° 38′, the snows were not gone, nor was there any appearance of vegetation, till the middle of May. Which, if to be relied on, as

* Stockholm in Sweden lies in lat. 59° 20′ N. and Tobolski in Siberia, in 58° 12′; yet it is found by observation that the usual cold in the latter, very much exceeds that of the former. Now, Tobolski is 50° of long. more easterly than Stockholm; of course so much further from the Atlantick ocean. Doth not this observation confirm the truth of our hypothesis?

as the common course of things, is a strong confirmation of the doctrine just proposed.* †

But it is more than time to close this paper, already much too lengthy; which I shall do, after observing that, although I know not whether either, or both the causes herein suggested, may be judged adequate to the effects, which I have ascribed to them; yet I think we must admit the operation of some partial or local cause (such as greater dephlogistication) to account for the greater degree of cold in Europe formerly, than at present — as well as of some general cause (such as the general course of winds from the westward in the temperate zone) to account for

* It is a common observation among those of our navigators, who frequently traverse the Atlantick, in or near our latitude, that westerly winds are of all, others, the most usual; which has occasioned the sailors to call the passage from the eastward *uphill.* And it is observed in Mr. Walter's Account of Anson's Voyage, that, in the Pacifick ocean, in the latitude of 30° or 32° North, the winds almost constantly blow from the westward, though in but moderate gales; but that in more northerly latitudes, as 40° or 45°, there are steady westerly winds; the writer therefore supposes, that the Accapulco ship might perform her voyage in much less time, if she stood further to the northward, *where westerly winds constantly prevail,* than she does, while she pursues her old tract. These observations are additional proofs of the hypothesis advanced in this paragraph. Whether westerly winds prevail in the southern temperate zone, I know not; but, if they do, the western coast of South America is probably warmer than the eastern, in latitudes similar to ours. If the course of the winds in our latitudes be generally from the west, will not this circumstance alone occasion the atmosphere of Europe to be more humid than the American, as the air from the sea must be more charged with the watery vapours, than the land air?

† Vasennius in his Geography, page 609, 4th Edition, Lond. informs us, that in "the north part of China, though in a latitude not more northern than Italy, the cold feels very sharp, and the great rivers and lakes are frozen"—and page 611, that "In Japan, which extends from 31° to 39° N. they have a cold snowy wet winter."

for the greater degree of cold on the eastern confines of Asia, than on the western of America.

Be this however as it may, I flatter myself that, what is here offered, may excite some persons of taste and leisure for such inquiries, to attend to the subjects here treated, and to examine with freedom the theory here advanced; that so, if it shall be found agreeable to reason and experience, it may be illustrated and confirmed; or, if otherwise, that it be confuted and exploded.

Salem, September, 1788.

POSTCRIPT,

To a Paper entitled, An Estimate of the Excess of the greatest Heat and greatest Cold of the American Atmosphere beyond the European, under the same Parallel of Latitude, &c.

SINCE the Academy did me the honour to read a paper I presented them in November 1788, entitled, *An Estimate of the Excess of the Heat and the Cold, &c.* I have had the pleasure of reading in the Philosophical Transactions, Vol. lxxvii. Article xv. an account of some very curious experiments made by our countryman Sir Benjamin Thompson, at Manheim, in the Palatinate in Germany; by which it appears that eider-down, cotton wool, raw silk, &c. yield as much and as pure dephlogisticated air, as the leaves of any kind of vegetables by the same process; that is, by exposing them, when immersed in water, to the action of the sun's rays: and therefore, that most probably, this pure air is derived from the water in which they are thus immersed, and not from the substances, whether vegetable, animal, or

mineral,

mineral, which are thus heated. Whence it seems to follow, that it is far from certain that any such pure air, or indeed any air at all, is derived from the leaves of plants exposed to the sun, as was suggested and seemed to be proved, by the experiments of Drs. Priestley, Ingenhousz, and others. If this be really the truth of the case, and air is not produced from the leaves of vegetables, as in the paper just now mentioned I have supposed it to have been; then, all the subsequent reasoning upon this hypothesis is void of foundation, and must fall to the ground. But it ought to be noted, that the facts and observations contained in the *Estimate*, which shew our atmosphere to be really *drier* than the European, are not at all affected by the failure of this hypothesis, but remain in their full force, though I may have mistaken the cause, when I attributed it to the purity of the air derived from the leaves of vegetables.

Further, since writing the paper before mentioned, I have accidentally been informed of a fact, which confirms the idea, that our evergreens are, if not the cause of dephlogisticating the air, yet somehow the cause of an increase of cold. The fact I mean is, *that frosts are commonly observed to appear much earlier every autumn, as well as later in the spring, in the neighbourhood of pine and other evergreen woods, than in other places, or than in the neighbourhood of other woods which drop their leaves in the winter.* And this I find confirmed by every one I have since inquired of, whose business or situation leads them to attend to the matter; and I am told, it is a common observation, though I confess I never heard of it, before I presented the paper to the Academy.

If

If this observation be well founded, then (whatever may be the fate of Dr. Priestley's and Dr. Ingenhousz's experiments) our pine woods are a source of cold, which Europe is now in a great measure deprived of; as there is no doubt but that trees of the evergreen, as well as of every other kind, are now few, and thinly scattered over that continent, compared with what they must have been in past ages, or than they are in America at present.

Salem, November, 1790.

A TABLE of the greatest HEAT and COLD, and of the Mean of the greatest Heat and Cold, collected from Observations made for a course of Years in twenty different Cities in Europe; as exhibited in the Ephemerides Meteorologicæ Palatinæ: *and at Salem, in North America, for seven Years: shewing the Excess both of Heat and Cold in America, beyond that of Europe in the same Latitudes; by the Thermometers both of Mr. Reaumur, and Fahrenheit.*

Names of Places	Lat. north ° ′	T. of years.	Greatest Heat by thermom. of		Mean of the greatest heats.		Greatest Cold by thermom. of		Mean of the greatest Colds.	
			Reaumur.	Fahrenheit.	Reaumur.	Fahrenheit.	Reaumur.	Fahrenheit.	Reaumur.	Fahrenheit.
Stockholm	59 : 20	3	+24,8	+ 87,80	+23, 1	+83,98	—21,5	—16,37	—18,75	—10,19
Copenhagen	55 : 40	4	+23,6	+ 85,10	+22,12	+81,77	—13,8	+ 0,98	—12, 9	+ 2,98
Berlin	52 : 32	4	+28,0	+ 95, 0	+25, 5	+89,37	—15,8	— 3,55	—14, 5	— 0,62
Sagan	51 : 42	5	+28,6	+ 96,35	+26,16	+90,86	—23,7	—21,32	—19,66	—12,23
Erfurt	51 : 04	5	+27,6	+ 94,10	+25, 6	+89, 6	—20,5	—14, 1	—15, 6	— 3, 1
Mons	50 : 25	5	+28,0	+ 95, 0	+25, 4	+89,15	—17,5	— 7,37	—23, 7	+ 1,18
Prague	50 : 04	4	+28,3	+ 96,35	+26, 7	+92,07	—22,0	—17, 5	—19, 9	—12,77
Wurtzburg	49 : 46	5	+31,3	+102, 4	+27, 5	+93,87	—22,4	—18, 4	—16, 0	— 4, 0
Manheim	49 : 27	5	+27,2	+ 93,15	+25, 6	+89, 6	—18,2	— 8,95	—13, 7	+ 1, 2
Ratisbon	48 : 56	4	+28,7	+ 96,57	+21, 2	+79, 7	—20,2	—13,45	—15, 3	— 2,42
Buda	47 : 40	4	+27,0	+ 92,75	+26, 1	+90, 7	—15,2	— 2, 2	—12,77	+ 4,26
Peissenberg	47 : 47	5	+23,3	+ 84,35	+19, 6	+76, 1	—18,2	— 8,95	—14, 1	+ 0,28
M. St. Andex		5	+25,6	+ 89,60	+25, 7	+89, 8	—17,6	— 7,60	—13, 5	+ 1,13
Tegernsee	47 : 37	5	+24,5	+ 87,12	+22, 9	+83, 5	—19,7	—12,32	—13, 9	+ 0,73
St. Gotthard	46 : 31	4	+15,5	+ 66,87	+13, 5	+62, 3	—19,0	—10,75	—16, 3	— 4,67
Geneva	46 : 12	3	+27,0	+ 92,75	+25, 3	+88, 9	—13,4	+ 1,85	— 9, 7	+10, 2
Rochelle	46 : 09	4	+27,5	+ 93, 9	+26, 0	+90, 5	— 9,5	+10,63	— 6, 7	+16,93
Padua	45 : 22	5	+29,0	+ 97,25	+26, 4	+91, 4	—10,8	+ 7, 7	— 6, 7	+16,93
Marseilles	43 : 17	3	+26,0	+ 90, 5	+25, 6	+89, 6	— 3,5	+24,13	— 2, 0	+27, 5
Rome	41 : 53	4	+24,3	+ 86,67	+23,75	+85,43	— 0,4	+31, 1	+ 0,65	+33,46
Mean					+24,19	+86,41			—12,75	+3,31
Salem, N. A.	42 : 31	7	+32,9	+106	+28, 9	+97,02	—19,1	—11, 0	—15, 3	— 2,42

VI. A Table of Results, from a Course of Observations made on the Heat of the Atmosphere, by Fahrenheit's Thermometer, in the Years 1786, 1787, 1788, 1789, 1790, 1791, *and* 1792, *at Salem, in Massachusetts, Lat.* 42° 34′ *N. Shewing the Mean Heat of each Month, at four Observations per Day, and the Mean of each Observation :— The hottest and coldest Day in each Month; and the greatest Variation of the Thermometer in* 24 *Hours :—The Number of Days in each Year, in which the Thermometer rose to* 80° *and upwards; the number of days to* 90° *and upwards; and the hottest Day :—The Number of Days, in which the Thermometer sunk to* 32° *and below; the Number of Days to Zero and below; and the coldest Day. To which are added, Results from the whole; which shew the Mean Temperature of each Month, Season, Year, &c. &c. By* EDWARD AUGUSTUS HOLYOKE, *M. D. F. A. A.*

1786.

Mean of each time of observation, and of each month, at 4 observations per day.

Mth.	8 A.M.	Noon.	⊙ sets	10 PM	Mean of Month.
Jan.	22. 5	30. 2		21. 7	24. 8
Feb.	27. 2	34.		24. 7	28. 63
Mar.	38. 7	45. 7		34. 8	39. 73
Apr.	43. 3	48. 5		30. 7	40. 8
May	58. 3	62. 6		50. 6	57. 17
June	72. 1	79.		64. 4	71. 6
July	71. 2	78. 5		64. 2	71. 3
Aug.	68. 6	75.		63. 1	68. 9
Sep.	60. 6	69. 1		57. 8	62. 5
Oct.	53. 7	63. 3		50.	55. 6
Nov.	32. 9	39. 6		31. 7	34. 7
Dec.	24. 7	31. 4		23. 6	26. 56
Mean	47. 82	54. 74		43. 1	48. 53

The hottest and coldest day; the greatest variation in any 24 hours; and range of each month.

	Hottest day.	Coldest day.	Greatest change in 24 hours.	Range of each month.
Jan.	22d 48°	17th −11°	21st 32°	59°
Feb.	27 50	11 11	11 30	39
Mar.	26 78	10 25	27 21	53
Apr.	16 63	2 25	11 15	38
May	28 71	4 45	21 17	26
June	4 93	9 55	4 30	38
July	16 91.5	28 55	27 25	36-5
Aug	5 89	27 52	6 17	37
Sep.	30 80	23 42	30 24	38
Oct.	1 85	31 29	18 22	56
Nov.	7 59	28 4	28 30	52
Dec.	31 45	12 —5	13 30	50

Days on which the ther. was at 80° and upwards, at 90° and upwards, and hottest day.

Thermometer at 80° and upwards, in		Thermom. at 90° and upwards, in	
June	13 days	June	1 days
July	11	July	3
August	8		4
September	2		
October	1	Hottest day. June 4th, 93°	
	35		

Days on which thermometer was at 32° and under, at 0 and under, and the coldest day.

Thermometer at 32° and below, in		Thermom. at 0° and under, in	
January	27 days	January	3 days
February	25	Dec.	1
March	9		4
April	3		
October	1		
November	18	Coldest day. Jan. 17th, —11°	
December	25		
	108		

1787.

Mth.	8 A.M.	Noon.	⊙ sets	10 PM	Mean of Month.
Jan.	23. 9	30. 6	26. 6	23. 7	26. 2
Feb.	21. 5	30.	25. 6	22.	24. 77
Mar.	34. 5	42. 2	36. 6	31. 1	36. 1
Apr.	43. 4	53. 1	46.	40. 6	45. 77
May	56.	61. 9	54. 4	49. 8	55. 52
June	66. 6	71. 5	63. 6	59. 5	65. 3
July	69. 8	76. 5	67. 1	62. 7	69. 25
Aug.	70.	77. 8	69. 5	62. 7	70.
Sep.	59. 8	67. 2	60.	55.	60. 5
Oct.	48. 3	56. 5	48. 7	43. 1	49. 15
Nov.	39. 8	47. 5	40.	38. 1	41. 35
Dec.	28. 4	35. 6	31. 6	27. 2	30. 7
Mean	46. 83	54. 2	47. 47	42. 86	47. 88

	Hottest day.	Coldest day.	Greatest change in 24 hours.	Range of each month.
Jan.	3d 48°	19th —5	19th 29°	53°
Feb.	12 50	10 —3	11 40	53
Mar.	19 62	8 16	24 27	46
Apr.	4 75	2 22	5 28	53
May	6 78	15 42	6 22	36
June	14 91	7 50	27 23	41
July	8 91	17 55	8 24	36
Aug.	9 89	1 53	9 19	36
Sep.	10 87	15 44	12 17	43
Oct.	3 70	18 32	4 25	38
Nov.	15 65	2 25	15 24	30
Dec.	5 48	16 12	6 17	36

Thermometer at 80° and upwards, in		Thermometer at 90° and upwards, in	
June	10 days	June	1
July	13	July	1
August	13		2
September	2		
	38	Hottest day, June 4th and July 8th 91°	

Thermometer at 32° and under, in		Thermom. at 0° and under, in	
January	25 days	January	1
February	27	February	3
March	17		4
April	6		
October	1		
November	9	Coldest day. Jan. 19th, —5°.	
December	26		
	111		

Mean of each time of observation, and of each month, at 4 observations per day.

1788

Mth.	8 A.M.	Noon	⊙sets	10 PM	Mean of Month.
Jan.	19.3	27.7	24.2	19.5	22.67
Feb.	20.3	28.3	23.8	20.5	23.2
Mar.	33.1	39.3	34.4	30.3	34.27
Apr.	43.8	52.2	43.2	41.9	45.27
May	55.3	62.7	55.2	51.6	56.2
June	64.5	70.3	63.1	59.4	64.32
July	72.1	81.8	70.5	66.6	72.07
Aug.	69.2	78.4	68.3	66.5	70.6
Sep.	60.9	72.5	62.7	55.3	62.85
Oct.	46.4	55.	49.8	45.5	49.17
Nov.	41.3	49.7	45.7	40.6	44.3
Dec.	24.3	31.5	28.	24.9	27.2
Mean	45.87	54.12	47.40	43.55	47.676

1789

Mth.	8 A.M.	Noon	⊙sets	10 PM	Mean of Month.
Jan.	24.	30.1	26.4	23.7	26.05
Feb.	18.9	28.4	22.4	17.1	21.7
Mar.	33.7	39.5	31.8	31.	34.
Apr.	44.3	51.6	45.2	40.3	45.35
May	54.8	58.7	50.2	46.	52.42
June	68.2	76.7	67.1	62.3	68.57
July	72.	79.1	69.9	65.6	71.65
Aug.	69.6	76.9	69.7	65.7	70.47
Sep.	59.3	68.7	62.6	57.1	61.92
Oct.	42.7	51.5	46.3	41.6	45.52
Nov.	39.3	45.3	41.3	38.8	41.17
Dec.	31.2	37.2	34.1	31.	33.37
Mean	46.5	53.64	47.25	43.35	47.68

The hottest and coldest day; the greatest variation in any 24 hours; and range of each month.

1788

	Hottest day.		Coldest day.		Greatest change in 24 hours.		Range of each month.
Jan.	29th	40°	14th	–1°	14th	26°	41°
Feb.	3	44	5	—2	5	26	46
Mar.	31	58	2	8	31	21	50
Apr.	19	67	21	32	2	26	35
May	21	76	11	41	22	27	35
June	7	89	15	51	8	28	38
July	12	93	1	56	12	38	37
Aug.	29	88	31	54	5	18	34
Sep.	5	85	20	42	30	29	43
Oct.	12	68	30	21	13	29	47
Nov.	5	77	24	21	25	41	56
Dec.	15	52	24	—4	16	24	56

1789

	Hottest day.		Coldest day.		Greatest change in 24 hours.		Range of each month.
Jan.	29th	41°	7th	9°	8 h	21°	32°
Feb.	11	40	2	—2	3	26	42
Mar.	12	51	4	10	4	31	61
Apr.	19	66	21	32	21	24	34
May	30	85	1	38	31	26	47
June	30	94	1	52	10	20	42
July	24	94.5	4	57	4	33	27
Aug.	11	91	28	50	29	22	41
Sep.	21	85	19	46	29	18	39
Oct.	20	61	30	29	21	17	32
Nov.	14	58	18	20	23	20	38
Dec.	7	56	19	14	19	22	42

Days on which ther. was at 80° and upwards, at 90° and upwards, and hottest d.

1788

Thermometer at 80° and upwards, in		Thermom. at 90° and upwards, in	
June	5 days	July	1 day
July	13		
August	8		1
September	1		
	27	Hottest day. July 12th, 93°	

1789

Thermometer at 80° and upwards, in		Thermom. at 90° and upwards, in	
May	1 days	June	4 days
June	12	July	5
July	13	August	1
August	11		10
September	1	Hottest day. July 24th, 94°.5	
	38		

Days on which thermometer was at 32° and under, at 0° and under, and the coldest day.

1788

Thermometer at 32° and under in		Thermom. at 0° and under in	
January	30 days	January	2 days
February	26	February	2
March	19	Dec.	2
April	2		6
October	4	Coldest day. Dec. 24th, —4°	
November	6		
December	21		
	108		

1789

Thermometer at 32° and under in		Thermom. at 0° and under in	
January	28 days	February	3
February	26		3
March	16	Coldest day. Feb. 2d, —2°	
April	1		
October	4		
November	9		
December	21		
	105		

Mean of each time of observation, and of each month, at 4 observations per day.

1790 *Mth.*	8 A.M.	Noon	⊙ setg	10 PM	Mean of month.	1791 *Mth.*	8 A.M.	Noon	⊙ sets	10 PM	Mean of month.
Jan.	26. 5	32. 3	29. 4	26. 5	28. 67	Jan.	23. 8	31.	26. 3	23. 3	26. 1
Feb.	24.	30. 3	26. 5	22. 3	25. 77	Feb.	20. 2	33.	24. 9	20. 3	24. 6
Mar.	31. 1	36. 6	33.	29. 3	32. 5	Mar.	36. 2	42. 5	37. 6	34. 1	37. 6
Apr.	41. 7	49. 7	41. 6	38. 1	42. 72	Apr.	46. 7	54. 6	47. 6	42. 5	47. 85
May	57. 7	61. 8	54. 5	49. 1	55. 77	May	59. 2	67.	62. 2	53. 5	60. 47
June	65. 7	73. 8	64. 3	60.	65. 95	June	69. 7	77. 7	67. 7	62. 7	69. 45
July	69. 8	78. 4	69. 6	64. 6	70. 6	July	72. 1	81. 3	70. 5	66.	72. 47
Aug.	66. 7	73. 2	66. 2	62. 6	67. 17	Aug.	70. 3	78. 2	70. 4	65. 8	71. 17
Sep.	57. 9	67. 4	61. 5	56. 6	60. 85	Sep.	59. 7	67. 9	61. 1	57. 3	61. 5
Oct.	46. 8	56. 2	51. 2	45. 7	49. 97	Oct.	43. 4	52. 8	47. 5	42. 5	46. 55
Nov.	35. 5	42. 3	39.	34. 3	37. 77	Nov.	35. 8	44. 5	40. 7	35. 5	39. 12
Dec.	16. 5	23. 9	20. 3	17. 1	19. 45	Dec.	28. 6	34. 7	31. 2	28. 3	30. 7
Mean	44. 99	52. 16	46. 32	42. 11	46. 43	Mean	47. 14	55. 43	48. 97	44. 32	48.965

The hottest and coldest day; the greatest variation in any 24 hours; and range of each month.

1790	Hottest day.	Coldest day.	Greatest change in 24 hours.	Range of each month.	1791	Hottest day.	Coldest day.	Greatest change in 24 hours.	Range of each month.
Jan.	3d 51°	21st 14°	7 28	31°	Jan.	10th 43°	22d 0°	22d 34°	43°
Feb.	15 46	10 —3	9 25	49	Feb.	14 46	17 1	17 37	45
Mar.	28 50	9 3	4 26	47	Mar.	17 58	1 15	3 19	43
Apr.	4 69	7 24	4 28	35	Apr.	21 70	3 32	20 25	38
May	10 81	7 42	10 31	39	May	29 90	5 37	13 40	53
June	17 94	2 51	17 39	43	June	13 91	20 50	17 28	41
July	6 89	19 57	21 24	42	July	13 96.5	2 53	6 24	43
Aug.	14 93	30 53	30 23	40	Aug.	29 88	20 56	1 23	32
Sep.	10 83	23 44	10 23	39	Sep.	24 80	28 44	25 27	36
Oct.	30 64	27 28	27 24	36	Oct.	2 80	31 30	3 26	50
Nov.	15 58	26 17	30 14	41	Nov.	8 63	4 17	26 28	46
Dec.	11 39	19 —8	19 28	47	Dec.	27 49	24 10	3 23	39

Days on which ther. was at 80° and upwards, at 90° and upwards, and hottest day.

1790: Thermometer at 80° and upwards in		1790: Thermom. at 90° and upwards in		1791: Thermometer at 80° and upwards in		1791: Thermom. at 90° and upwards in	
May	1 days	June	1 day	May	7 days	May	1 day
June	5	August	1	June	15	June	3
July	14		2	July	16	July	8
August	7	Hottest day. June 17, 94°		August	15		12
September	2			September	1	Hottest day. July 13th, 96°. 5	
	29			October	1		
					55		

Days on which thermometer was at 32° and under, at 0° and under, and the coldest day.

1790: Thermometer at 32° and under in		1790: Thermom. at 0° and under in		1791: Thermometer at 32° and under in		1791: Thermom. at 0° and under in	
January	29 days	February	2	January	27	January	1
February	22	December	3	February	26		1
March	20		5	March	14	Coldest day. January 22d, 0°	
April	2	Coldest day. Dec. 19th, —8°		April	1		
October	2			October	5		
November	14			November	15		
December	30			December	23		
	119				111		

1792

Mean of each time of observation, and of each month, at 4 observations per day.

Mth.	☉ris	8 AM	Noon	☉set	10 PM	Mean
Jan.	14. 6	15. 9	23. 9	20. 4	16. 5	19. 17
Feb.	21. 1	23. 9	32. 7	27. 6	23. 38	26. 89
Mar.	33. 3	37. 6	45. 5	39. 4	35. 9	39. 6
Apr.	40. 5	47.	54. 4	48. 3	43. 6	48. 3
May	50. 6	59. 7	68. 2	59. 5	54. 8	60. 55
June	58.	65. 7	73.	63. 1	59. 5	65. 3
July	62. 2	71.	78. 3	70.	64. 6	70. 96
Aug.	60. 5	68. 6	77.	69. 6	64. 2	69. 85
Sep.	49. 7	56. 9	66. 2	59. 3	54.	59. 1
Oct.	45. 3	52. 6	58. 6	53. 1	47. 1	52. 85
Nov.	36.	39. 2	47. 4	43. 4	38. 9	42. 22
Dec.	20. 1	22. 3	31. 9	28. 3	23. 3	26. 45
Mean		46. 7	54.76	48. 5	43. 81	48. 44

The hottest and coldest day; the greatest variation in any 24 hours; and range of each month.

	Hottest day.	Coldest day.	Greatest change in 24 hours.	Range of each month.
Jan.	3d 44°	23d −11°	28 22°	55
Feb.	4 44	11 8	4 23	44
Mar.	28 62	6 28	28 22	34
Apr.	2 74	15 34	23 23	40
May	31 94	18 42	27 35	50
June	20 93	8 48	29 25	45
July	1 90	24 56	2 25	34
Aug.	19 95.5	31 50	20 28	45. 5
Sep.	8 86	27 37	9 30	49
Oct.	10 70	22 32	3 23	38
Nov.	5 66	21 22	20 22	44
Dec.	5 48	19 4	28 18	44

Days on which thermometer was at 80° and upwards, at 90° and upwards, and hottest day.

Thermom. at 80° and upwards in		Thermom. at 90° and upwards in	
May	7 days	May	2 days
June	10	June	2
July	15	July	1
August	10	August	3
September	2		
	44		8
		Hot. d. July 19,95°5	

Days on which thermometer was at 32° and under, at 0° and under, and the coldest day.

Thermom. at 32° and under in		Thermom. at 0° and under in	
January	29 days	January	3 days
February	25		3
March	10		
April	1	Coldest day.	
October	1	January 23, —11°	
November	8		
December	28		
	102		

Results from the whole 7 years observations.

Mean of means of each month.	
Jan.	24. 808
Feb.	25. 07
Mar.	36. 257
Apr.	45. 151
May	56. 871
June	67. 212
July	71. 296
Aug.	69. 751
Sep.	61. 317
Oct.	49. 544
Nov.	40. 09
Dec.	27. 775
Mean	47°. 928

Mean Heat of each Season of the Year.

	Wint.	Spring	Sum.	Aut.
1786	25. 74	45. 9	70. 6	50. 93
1787	25. 843	45. 796	68. 188	50. 33
1788	25. 523	45. 246	68. 996	52. 10
1789	24. 983	43. 922	70. 23	49. 53
1790	29. 266	43. 62	67. 906	49. 53
1791	23. 383	48. 62	71. 03	49. 056
1792	25. 586	49. 483	68. 73	51. 39
Mean	25.760	46.083	69.380	50.411

Mean of Spring and Autumn 48.247
Mean of Summer and Winter 47.57
47.908

Mean of each time of observation.	
8 A. M.*	46. 55
Noon	54. 15
Sun set	47. 60
10 P. M.	43. 7
Mean	48.

N. B. The observation at sun setting,* nearest the mean temperature.

Mean temperature of each year.	
1786	48.53
1787	47.88
1788	47.676
1789	47.68
1790	46.43
1791	48.965
1792	48.44
Mean tem.	47.945

From the mean of all these means, the annual temperature of our atmosphere appears to be 47°. 945. But as none of these observations were made at the coldest time of the day, viz. about sunrising, it is probable that the true temperature may be stated a little lower, viz. at 47°. 50.

The range of the Therm.

Greatest range in 24 hours, Nov. 25, 1788, 41°

Greatest monthly range January 1786 59°

Least monthly range. May 1786 26

Range of each season.
Wint. from —11 to 56:67.
Sum. from 48 to 96. 5:48.5
Spring from 3 to 94:91
Aut. from 4 to 87:83

The hottest day, July 13, 1791, 96.5
Coldest day, Jan. 17 1786 & Jan. 23, 1792, —11
Greatest range in 7 years, 107.5
The mean annual range is 99.7

Mean number of hot and cold days.

Mean number of days at 80° and upwards. 38
Mean number of days at 90° and upwards 5 4-7
Mean heat of hottest days. 93°.9

Mean number of days at 32° and under 109, 2-7
Mean number of days at 0° & under 3, 5-7
Mean heat coldest day —5°.8

Greatest heat of the day is commonly between one and 3 P. M. and in 1792 was 54. 76.
Greatest cold is commonly about sunrising, and in 1792 was 41.
Mean heat of year at 2 observations (nearly equal to mean at sunsetting) 47. 88.

Here the mean temperature is deduced from the mean of the hottest and coldest time of the day, for one year, viz. 1792: which agrees tolerably with that deduced from the mean of 4 observations per day: But which shews that the temperature ought to be stated lower than 47°. 945 and will probably reduce it to 47°. 50 or 47°. 60.

N. B. The Thermometers employed in these observations were accurate instruments made by Martin Nairne and Gilbert in London, and agreed well with each other, and were suspended in the shade in the open air, on the north side of a house in the main street in Salem, about 6 or 7 feet from the ground.

VII. *A Letter on the Retreat of Swallows in Winter. From the Reverend Mr.* PACKARD.

Marlborough, January 13th, 1791.

SIR,

IN a review published in England, of the first volume of the Memoirs of the American Academy of Arts and Sciences, I noticed particularly the observations it contained, upon your letter to the late Governour Bowdoin, respecting the torpid state of house-swallows in winter. The reviewers, you recollect, conclude with wishing for the most circumstantial confirmation of the fact, if it be a fact, that those birds exist in mud during the cold season. Knowing your curiosity, and having accidentally received some hints tending to the subject, I pursued them to the following effect.

Lieutenant Nathaniel Orcutt, now living in Bridgewater, a gentleman of indubitable veracity, with whom I am personally acquainted, in answer to a letter, wrote me, that Mr. Ignatius Turner, formerly of Scituate, now deceased, a man of truth and probity, had repeatedly told him, that in Scituate, a mill-pond being drawn off suddenly by a breach in the dam, he saw the swine of that neighbourhood rooting up house swallows from the mud, from which the water was drained. Being in the winter season, it was a matter of speculation to others as well as to himself. He saw them eating the swallows, he said, and saw the wings of some lying on the mud, after the swine had done rooting. He

wrote

wrote me further — that Captain Polycarpus Edson of Bridgewater, merchant, gave him the following account, the truth of which Mr. Orcutt does not scruple, viz. That he, Captain Edson, being at a place called Egg Harbour, in the month of February, about seventeen years ago, observed a large cedar blown down, near his work, which raised a root proportioned to its trunk. The next day, being the remarkably cold Sabbath, which many among us have sufficient reason to remember, in company with another man, now living in a neighbouring state, he went to this tree, and found a large number of house swallows sticking in the mud of the root, and in that from which the root was torn. The weather was so extremely severe, that such as were naked, wholly uncovered, were not only torpid, but frozen. Prompted by curiosity, they dug into the mud, which the root had left; and found, as he expressed it, swallows as thick as one could lie by the side of another. Taking one that was not frozen, they carried it to their temporary cottage, and laid it by a fire. The little bird, as if February and May had exchanged places, soon perceived the difference of air, began to move; balance her wings; and to resume her natural activity: but the experiment, being attended with some difficulty, was given up with this observation, "with a little attention, she would undoubtedly fly in an hour or two."

Since the receipt of Mr. Orcutt's letter, I have seen Captain Edson. He related these facts to me nearly in the same manner; and, in some instances, used the same terms and phrases contained in the letter. He added, that by what they saw, there must have been bushels of swallows

which

which that tree covered in its natural state. The tree stood in poachy land, covered with moss, a mere morass, without any sward: — many holes and chasms appearing near where the tree stood, he supposes, they descended in those apertures, which were probably filled, or nearly filled with water at the time of their entrance.

Captain Edson told me, he was ready to make oath to this narrative; and that he scrupled not a deposition to the same purpose, might be obtained of ——— (I cannot recollect his name) the man, who was in company with him at Egg-Harbour.

I have said, I could place entire confidence in Lieutenant Orcutt as a man of truth; and now say, I have not the smallest reason to doubt of Captain Edson's veracity.

Whether you will think this letter entitled to a silent acknowledgment, I cannot say; but you know my cheerfulness in complying with any request, with which you are pleased to honour me, and that

I am,
Honoured Sir,
Very affectionately,
Yours,
ASA PACKARD.

The Hon. SAMUEL DEXTER, Esq. F. A. A.

VIII.

VIII. *A Letter on the Retreat of Swallows, and the Torpid State of certain Animals, in Winter. From* SEVERYN J. BRUYN, *Esq.*

Bruynswyke, Ulster County, April 3d, 1790.

SIR,

I AM sensible, it has long been an inquiry, where, or into what places, swallows retreat during the winter; and that there have been various conjectures on this subject. The account, which Mr. Hathorn, one of the members of Congress, has given you of their being found in hollow trees in the winter season, is a fact to which I can fully testify. In the year 1787, about the 20th of March, I was passing with some hunters through the country near Neversink creek, in the great Hardenbergh Patent; where I observed a large hollow chesnut tree to have been broken off, near the ground, by the force of the wind. It burst open by falling, so as to expose the hollow a considerable way along the trunk. I judged the tree to be about ten feet in circumference; and the hollow to extend thirty or forty feet from the stump; which was so large, that the sound wood did not appear to be more than four inches thick. In the hollow of this tree were an immense number of swallows, amounting, I believe, to many thousands. They were all dead; many were perfectly entire, and in their natural form; but some of them were so far decayed, as that, on moving or taking them up, their wings separated from their bodies. The reason of their being all dead, and not in a torpid

state,

state, I imputed to their being exposed to the severity of the weather, during the winter, by the tree's bursting open when it fell. They were of the species which we call chimney swallows. Their colour is much darker than that of the barn swallow. The large feathers in the tail terminate in strong sharp points, by which they support themselves along the inside of chimneys, whilst they are building their nests. They fold their tail feathers in a direction perpendicular to their bodies, which is contrary to that of the barn swallows. Large numbers of these swallows annually build in the chimneys of my house; and frequently descend down into the rooms, by which means they have been very familiar to me. I can therefore, positively declare, that those I found in the hollow chesnut, were of the same species. This chesnut was about forty miles west of that part of Hudson's river, which is about ninety miles distance from New-York on a north line; or was probably between the latitudes of 41° 30′ and 42° north.

The island in the Neversink Creek, where Mr. Baker found a large number of swallows, in the beginning of March, 1789, in a hollow beech tree, which were mentioned in a late New-York paper, lies about ten miles from the place, where I found the swallows in the chesnut. I am well acquainted with Mr. Baker; and conceive him to be a man of probity; but it is possible he might be mistaken in the species of swallows.

There are some curious facts in the natural history of the bear, which perhaps, you have not met with. About the

beginning of January, they retire to holes, or caverns, in ledges of rocks; and sometimes into hollow trees, where they remain in a state of torpitude, or rather profound sleep, until about the middle of the month of March; when they awake, and go abroad; at which time, the female brings out her cubs with her. It has been a matter of great uncertainty with hunters, in what way those cubs are generated: for the female bears have been killed in these holes, at all periods of their retirement; and frequently, just about the time of their coming out; and yet no cubs have been found in them; nor has there been found, after the most critical search, any appearance of an embryo, or foetus. I have often examined them; and it has been done by many hunters, particularly by the Indians (who consider this as a very mysterious matter) just at the time of their going abroad; the viscéra, where they might be expected to be found; and the whole of the intestines, were collapsed, and as clean as if they had been washed with water, except a hard lump of feces just within the orifice of the anus. If the bears are awaked before the proper time of their emigration, they will sleep no more; but rove about the remainder of the winter. I have known a tamed bear, of about four years old, to be waked up the first of February; after which it would not return to its torpid state; but required constant feeding the remainder of the winter. It is much the same with the rackoon, in regard to its sleeping, and waking, during the winter.

It

It will probably, be in my power to procure you a specimen of the swallows, which I will forward to any place you may direct in New-York.

I am, Sir,

Your very humble servant,

SEVERYN I. BRUYN.

Rev. Dr. CUTLER.

The following Account, published in a New-York Paper, is alluded to in this Letter.

POUGHKEEPSIE, *Feb.* 23, 1790.

"IN Ulster county, in the state of New-York, on an island in the Neversink Creek, nearly in the latitude of 41° 30′ N. a Mr. Baker, in the beginning of the month of March last, having cut down a large hollow beech tree, to his surprise, found the cavity in the tree, nearly filled with the common barn swallows of this country, in quantity (by his estimation) nearly two barrels. They were in a torpid state; but carrying some of those which were not injured by the fall of the tree, near a fire, they were presently reanimated by the warmth, and took the wing with the usual agility. This may be depended on as a fact."

IX.

IX. *A Practical Essay on Raising Apple Trees, and Making Cider, by Mr.* A. CROCKER, *of Somerset, England.*

To the PRESIDENT *and* MEMBERS *of the* AMERICAN ACADEMY.

GENTLEMEN,

THE due cultivation of the arts and sciences tends much to the advantage and glory of every state. Institutions like that of the *American Academy* cannot fail of producing happy effects on the surrounding world.

Notwithstanding I hold all due respect for *mathematical* and *philosophical disquisitions* (two important objects of your institution) yet I conceive that the world, in general, derive a principal advantage from the *due application* of the sciences to *the common concerns of life.*

Horticulture, even when considered as a philosophical *science only,* is truly a pleasing study; but when applied to practice, it becomes an art *profitable as well as pleasurable.* It is not my intention, in the following essay, to treat in a scientifick way, the subject of horticulture at large; but only to explain in a plain yet comprehensive way, one branch thereof; namely, the propagation of apple trees: adding thereto, as a subject naturally appendant, the most successful mode of converting the fruit thereof into a grateful, vinous, and salubrious liquor.

If the result of twenty years' experience and observation on the subjects can merit your attention, I presume that the following pages have some small claim to that exalted privilege.

vilege. Should, however, my ideas thereof be too sanguine, I beg you will do me the justice to believe that I am, in the utmost purity of intention, and with best wishes for the prosperity of your Academy,

Gentlemen,

your most faithful,

and very humble servant,

A. CROCKER.

Frome School, Somerset, in England, July 23*d*, 1789.

A Practical ESSAY *on* Raising APPLE TREES, *and* Making CIDER.

THE value and virtues of cider are too well known, to need any encomium from the pen of a modern writer: it will therefore, be more suitable to the intention of an essay on the subject, to point out the best means of procuring this excellent liquor in its purest state.

To do which, we must not only shew the proper management of the cider itself; but we must consider the best kinds of fruit for making it; the necessary management of the trees from which the fruit is produced; and also, the soil best adapted to the raising of those trees. The several subjects of this anti-climax will, in this essay, be considered in their natural order.

The soil which, by experience, the writer hereof has found to be best adapted to the raising of apple trees, in the *seminary,* is a light, rich loam, that has a less proportion of clay

to

to sand, than that which by writers on agriculture is generally considered a *due proportion for good mould.* It must not be understood, that the writer hereof means to recommend a soil composed merely of clay and sand, without the auxiliary aid of putrid mucilages, or other subjects of manure; but that he would recommend such an enriched soil, as is not of too strong a tenacity to favour the germination of the kernels sown therein. On soil it may only be further necessary to remark, that for the *stocks,* when transplanted from the *seminary* to the *nursery,* a greater degree of tenacity is required, than what is before mentioned: so that if the due proportion of clay to sand, in *common mould,* be as *one* to *four*; in the *seminary* for *apple kernels,* it may be as *one* to *five*; and for the *stocks* in the *nursery,* it may be somewhat more than as *one* to *four.*

Having prepared a bed of such soil in the seminary, as is mentioned above, let there be taken, in the latter end of October, or early part of November, from the strainings or pumice,* of a cider or verjuice cheese† a quantity of kernels, which sow thereon, covering them with sifted mould about an inch over; where they will germinate, and spring up about April following.

In

* *Pumice.* A provincial term, signifying pounded, or ground apples: perhaps a corruption from the French *pomme maché,* chewed apples.

† A nurseryman who raises apple trees for sale, may find his advantage in raising his stocks from *apple kernels;* but though a handsome tree may be thence raised in less time, it cannot be doubted that a tree raised from the kernel of a *crab,* or other *wilding,* will stand much longer in the orchard.

In this seminary the young stocks are to remain two years from the time of sowing; during which time no attention to them is necessary, but that of preserving them from external injuries, and pulling up such noxious weeds as may arise among them. At the end of this time, they must be taken up, thrown into two parcels (of great and small) and trimmed root and branch. The lateral branches must be shortened to about six inches, and the leading branch taken off at two feet from the upper roots. The spill or tap-root must also be taken off below the fibres, and the other roots pruned or plashed, in such manner that the whole ramifications of fibres appendant thereto may be spread in a circular, or at least in the most commodious, manner for drawing nourishment from the greatest space of ground possible after transplantation.‡ Such of those stocks as are more than an inch in circumference, must be transplanted in a quincunx order, two feet and half apart each way. The smaller ones may be transplanted in rows of a foot distance, and three or four inches apart in the rows: whence they may be again transplanted, at the proper distance for grafting, a year or two afterwards.

The method to be recommended for transplanting, is this. Let trenches be made in the nurserybed (which is supposed to have been cleansed and well dug aforehand) about a foot broad,

‡ Here it may be noted, that such crabbles as have before shewn a broad, well formed leaf, and run tall and straight, may be trained as *wilding trees;* which possibly may produce good cider fruit without grafting: whereby the nurseryman will save two years in bringing a tree to perfection. But, should the tree deceive him, when it shews its fruit, he may graft it in the head; and but little time will be lost by such means.

broad, and six inches deep. In these trenches the stocks are to be planted, at the distances before mentioned, in the manner following. The nurseryman must take a stock in his left hand, and therewith keep it firmly down to the bottom of the trench; and with his right, display the large roots in the best manner, and fasten them firmly, by putting in and pressing hard down some of the side earth, which was thrown out of the trench. Thus must he fill up the trench by degrees, frequently pulling out and spreading abroad with his fingers the fibrous ramifications, and pressing the earth close about the roots and stem. The greatest part of this labour should be done kneeling on a wad of straw, and going backwards as he plants.

This operation must be performed the latter end of October, or beginning of November, as the season may best serve, after a fall of rain. Here the stocks will remain until the second spring following, without requiring any attention more than that of guarding them from external injuries, or pruning off such lateral branches, as may happen to break out within six inches from the surface of the earth. It is advisable to permit the natural grasses, which may arise among the stocks, to form an imperfect sward, that the soil may acquire a greater strength for holding the stocks from being shaken by winds; so that the fibres may the more securely perform an uninterrupted labour of extracting nutriment from the earth.

In the second April after this transplantation, the stocks (being about three inches in circumference) will become

fit

fit for grafting; which is a work that requires the utmost care and skill of the nurseryman.

Various are the methods of this art which have been used and recommended by different persons: but the mode of grafting which the writer of this essay has found best to succeed, and which is certainly well adapted to stocks of this size, is that which is termed *whip* or *splice grafting*; and is thus performed. Some fourteen or twenty days before the stocks are to be grafted, take from some healthy, fruitful trees, of such kinds of apples as are intended to be propagated, a sufficient number of shoots of the last year*; tie them in separate bundles; label them; and put the larger ends thereof about three inches deep in the earth, in some exposed part of a garden, there to remain till they are wanted for use.† The

* If it were of use to the respectable society I am writing to, I might give a list of the names of cider-fruit most in esteem amongst us: such as the Styre, Redstreak, Panson apple, Bennet apple, Captain Nurse's kernel, Hagley's crab, Elton's yellow, and Old Quining, of Herefordshire: the Cockagee, Golden pippin, Old Redstreak, Royal Jersey, Cadbury apple, Castle pippin, Lemon pippin, and Salisbury apple, of Somersetshire: the Staverton Redstreak, Lidbrook ditto, Zachary's apple, Josey, Bittersweet, Orchardton pippin, and Baccamore of Devonshire: to which may be added, the Marsy, Marbrè, Double Pigeon rouge, Panachè, Ecarlotte de le Precoce, Pomme de Neige, Pomme de Chatelet, Pommes des Normandy, and various others lately imported hither from the European continent; but as names are accidentally or capriciously applied, and the characteristicks of apples thereby but imperfectly denoted, it may be better to remark, generally, that such apples (especially sour ones) as are of a yellow colour, and have red streaks on the sun side, whatever their names may be, are indubitably the best cider fruits.

† The reason for taking the grafts from the tree, and thus exposing them before they are grafted to the stock, is, that the juices in their tubes may evaporate through the bark, or be extravasated into the ground. Their tubes being in some measure thus emptied, will the more freely admit the ascent of sap from the stock after their union.

The nurseryman having mixed and well tempered with water a sufficient quantity of strong clay, the new feces of a horse which feeds on hay, and some fresh cow-dung, he must betake himself to his nursery; where, standing on the north side of a stock, he must place his left foot firmly on the earth, close thereto, and with a strong pruning knife take off the stock about five or six inches above the ground in a sloping manner; and on the south side, where the bark is clean, and free from knots, with a very keen pen-knife, he must take off a thin slice of bark and wood, of two inches or more in length. He must then take his graft, and shorten it to three or four buds, and from the part opposite the lower bud but one, slope it down so as to match the thin slice taken from the stock; and so place his graft and stock together, that the inner bark of each may coalesce: inserting the bottom of the graft into a small plash-incision made at the bottom of the slope of the stock: In this order he must bind his graft and stock firmly together with a list of bass-matting wetted; and then, by himself or assistant, surround both with a ball of his tempered clay: taking care so to close it about the stock and graft, as totally to exclude the external air.* To prevent the clay being chapped by cold winds or sun, it may be proper to wrap a thin layer of tow round the ball of clay; smoothing the whole with the hand, dipped in water. Thus he will proceed until all his stocks are grafted.†

In

* This operation of grafting should be performed, if possible, when the weather is moderate: not during the time of very cold winds or open sun shine.

† It is scarcely necessary to remark, that it may be prudent to graft each sort by itself. The labelling the grafts (before mentioned) was intended as an intimation of the propriety of so doing.

In this state the whole must remain until the latter end of June following;* at which time it will be necessary to cut through the ball of clay, displace it, and carefully take off the bass bandage; when, to his satisfaction (if the former operation was well performed) the nurseryman will perceive a perfect union of the graft and stock. If any extraneous shoots, around the stocks under the clay, should appear, they must be cut off with a keen knife, or slipped down with the fingers; and the whole clayed as before, but without any bass bandage.

The graft must now be left to make its advances towards a tree; which it will speedily do, with the few following helps. Early in the ensuing spring, the second clay must be taken off, and the stock cut slopingly away on the part opposite the graft. Should the graft not advance perpendicularly, it may be assisted by tying it to a small stake, fastened in the ground, near the stock. The lateral spurs or branches of the graft should not yet be taken off; as it is a known truth that trees acquire as much nourishment by the leaves, when in full verdure, as by the roots. But when the graft has arisen to the perpendicular height of somewhat more than six feet, let it be stopped (in the month of February) by cutting it off just above a bud of that height. The upper six buds will, in the course of the succeeding summer, form the ground-work of an apple tree head. This young head must, in the next spring, be shortened to four or five buds on each branch; always observing to leave the outer bud of each for the uppermost; thereby giving op-

portunity

* Frequently slipping off such buds as break out from the stocks below the clay.

portunity to the head to spread to a larger size. This operation of shortening the young shoots must be repeated in the ensuing spring, and perhaps in a third spring also; taking care in the preceding winters, to displace all such small branches, as cross or intercept the progress of others.

The second October following this period, those trees will become fit to plant out in an orchard; and the business of the nurseryman will nearly be ended.* Hence it appears, that in nine or ten years, an apple tree might be raised from the kernel to its plantation into the orchard; and of such kind of fruit as may be required or wished.†

It would amount to a tautology to repeat the necessary soil for an orchard, or the proper method of planting such trees, so much having been said on soil and transplantation, in the foregoing part of this essay: It remains therefore, to

* The site of an orchard has been so happily expressed by the English Pomonian Bard, that I shall take the liberty of speaking thereof in his own language.

> " Whoe'er expects his lab'ring trees should bend
> With fruitage, and a kindly harvest yield,
> Be this his first concern; to find a tract
> Impervious to the winds, begirt with hills
> That intercept the *Hyperborean* blasts
> Tempestuous, and cold *Eurus'* nipping force,
> Noxious to feeble buds: But to the west
> Let him free entrance grant."

† Were it not foreign to the intention of this essay, much might be said of the profits arising from a nursery properly managed; supposing the trees to be raised for sale. The writer will only remark that an acre of land will contain 6575 stocks, when planted at proper distances for grafting. Abate the 75 for accidents, there will remain 6500 trees; which, at the very low average price of *one shilling and six pence* a tree, will amount to £487 10s. A very handsome profit for an acre of land thus employed a few years only!

to remark only, that after the trees have been planted in the orchard, and properly staked to prevent their being moved by winds, &c. and have stood two winters and one summer, the heads must again be shortened, in the manner before directed.*

Thus (without further trouble, except a little pruning of such branches as intersect others) will new heads be formed, which will last for ages: and which will quickly repay all labour and cost, by successive crops of a golden fruit, highly estimable for its pleasing salubrious juice.

THE business of the cider-maker comes next under consideration: and therein much labour and attention must be employed, or the nurseryman has been working in vain.

About the beginning of October, he will find his apples, in general, sufficiently ripe for gathering: this he will know by slightly shaking a loaded bough of an appletree; for if the apples fall freely, it is an indication of their being sufficiently matured for his purpose.

He must then progressively shake the boughs of his trees (but not pole any, leaving the unripe apples for further maturation) and gather into heaps this golden harvest of *Pomona;*

* Trees thus managed, will be subject to very few disorders. Should they however, contract much moss, it may easily be removed with a pail-brush, or a piece of hair cloth often dipped in water. This may best be performed after some showers of rain. If in four or five years after the trees are planted out, any of them should appear (by the cleaving of the bark) to be hide bound, an incision should be made in the bark, with the point of a sharp knife, from the head to the ground. Should they be unthrifty, from metallick salts, pyrites, or other peculiarity of the soil wherein they are planted, lay the roots partly open, in the month of November, and when the frost has well operated on the opened soil, cover the roots with some rich compost, and close the whole again.

na; keeping each kind of fruit by itself. These heaps of apples (which should not be more than a foot deep) must remain in the orchard, or some other open place, for a fortnight or more; in which time they will, in general, acquire a sufficient degree of melioration to be made into cider. Should severe frosts set in, these heaps of apples must be covered with straw.

His mill, press, and vessels being previously cleaned,* he must now grind his apples to a pretty fine pumice; and, without much delay, proceed to the expressing of the juice; putting the pumice for that purpose, into very clean horse-hair cloths, or making a cheese thereof with bandages of sweet, clean wheat reed; taking care not to mix the pumice of various kinds of apples in one cider cheese, especially of sweet and sour fruits.

The juice thus expressed, must be strained through a fine hair sieve, into an open vessel, and thence conveyed to the casks, which should previously be placed in an open cellar: the bungs of which must be left unstopped, that the gross feces of the first fermentation may be discharged thereat.

Very particular attention must now be paid to the cider, to catch (as it were) the very moment of the first fining thereof,† and immediately to rack it off into a clean, open vessel; where it must remain eighteen or twenty hours: after which, it must be tunned into another cask, properly

cleaned,

* In none of which must any *lead* be used, lest a poison be thereby administered to those who drink the cider.

† This is best observed by drawing out a glass-full frequently, and holding it to the light: or it may pretty accurately be known by the discharged feces becoming brown, and beginning to crack.

cleaned, and if need be, matched.* This first fining of the cider, made at this season of the year, from sour fruit, will happen within thirty or perhaps twenty hours after making; that of sweet fruit, in not less than forty or fifty hours. Hence appears the necessity of keeping the different kinds of apples separate: for should a commixture of fruit be admitted, the juice of the sweet apple will not get fine until the second fermentation of that of the sour is begun; and a perpetual, unnatural fermentation will ensue, and continue perhaps for months; robbing the cider of its saccharine parts, and converting the whole into an acid liquor, unpleasant to the palate, and far less wholesome than it would have been, if duly managed.†

In

* Matching a cask is intended either to suppress an improper fermentation in the cider; to give some particular flavour thereto; or to increase the spirit thereof; and is thus performed. Take a strip of canvas cloth, about eighteen inches long and two broad: one half of which must be dipped in brimstone (melted in an earthen pan) whereon some pounded oris root, grains of paradise, coriander seeds, winters bark, ginger, cloves, cinnamon, or other pungent aromaticks, have been strewed. When this match is dry, it must be lighted, and put into a cask (pendent from the bung) in which a few gallons of cider have been beforehand tunned; where it must remain until it be burnt out. The cask must remain close stopped for an hour or more, and then rolled to and fro, to incorporate the fumes of the match with the cider: after which it must be nearly filled with the remaining cider. If the matching be intended merely to suppress an improper fermentation, the brimstone alone will be sufficient; but if an additional flavour and spirit be required, take such of the other ingredients as may be liked best. For increasing the spirit, it seems unnecessary to be over curious in the choice of the ingredients; for "All the pungent aromaticks have a surprising property of increasing the quantity of spirit."

Shaw's Chemical Essays.

† Chemists inform us, and experience confirms the position, that vegetable juices undergo *various fermentations*, very different in their effects. The first is called *vinous*, and so changes the property of the *must*, that, by distillation, an inflammable spirit may be extracted; which before, could not be done: the second is called *acetous*, con-

verting

In a very short time after the cider is become fine, if it be not racked as before directed, the acid fermentation begins. This may be perceived by a hissing noise, very distinctly heard, on applying the ear to the bung of the cask; and its effects can only be remedied (and that but in part) by drawing it off, as soon as perceived, into an open vessel, and suffering it there to remain for thirty or forty hours before it be again tunned into a fresh cask, and by mixing therewith some good French brandy, about the quantity of a quart to a hogshead of cider: or by matching the cask in manner spoken of in a preceding note.

But permit it to be supposed that the cider-maker has been cautious enough to catch the first fining above mentioned, and to have managed it according to the preceding directions, he will then have nothing more to do therewith until the February or March following; when it will be proper, in a mild season of fair weather, to give it another racking; and, if need be, to commix that which was made from sour fruit (which may be too pale) with that which was made from sweet fruit (which is generally dark coloured) thereby giving it as well a proper flavour, as that high amber colour, which, in the glass, is pleasing to the eye.* The

vessels

verting the liquor into vinegar: all the succeeding fermentations are of the putrefactive kind, forming mucilage, volatile alcali, &c. Hence appears a philosophick reason for attending particularly to the cider in its early stages; that the acetous and future fermentations may be prevented, and the first only permitted. See Fordyce's Elements of Vegetation, Elliott's Elements of Chemistry, &c. &c.

* Should the colour be still too pale, some lump sugar, melted in an iron stew pan, and commixed with some cider whilst in a fluid state, will heighten it to any degree of colour required.

vessels should at this time of racking be placed in a close cellar. At the return of the season, when apple trees are again in bloom, the cider will be found in a slight fermentation: until this operation of nature is past, the vessels must remain unstopped; but as soon as this is perfected, the cork may be placed on the bung, and daily pressed more and more tight. Should the cider be intended for bottling, it will be best to do it in the beginning of April; leaving the bottles uncorked, for eighteen or twenty hours after their being filled.

Thus, by the month of June or July, the cider-maker will be possessed of a sparkling, vinous, animating liquor; fit for the best citizens of "the free and independent states of America" to regale themselves with.

X. *Meteorological Observations made at Montreal, Canada, North America.*

State of FAHRENHEIT'S *Thermometer insulated, and exposed to the North.*

OCTOBER. 1791.

Oct.	Remarks before Noon.	*h. m.*		*h. m.*		Remarks after Noon.
26		7. 30	37.00 / 0		——	
27		7.	26.30 / 0	11.30	30. 0 / 0	
28		7.	29.30 / 0	12.	31. 0 / 0	
29		7. 30	38.00 / 0	12.	31. / 0	
30	Snow.	7.	27.00 / 0	12.	31. / 0	sleet and rain.
31	Rain.	7. 30	32.39 / 0	11.	34. / 0	dry.

NOVEMBER. 1791.

Nov.	Remarks before Noon.	*h. m.*		*h. m.*		Remarks after Noon.
1		7.00	27.00/0	11.00	26.00/0	
2	light snow.	7.30	23.30/0	11.30	22.00/0	
3	fair.	7.00	17.00/0	11.30	21.00/0	cloudy, frost all day.
4	light snow and sleet.	7.00	19.00/0	11.30	21.00/0	cloudy, moon light at intervals.
5	overcast, threatening snow.	7.00	28.00/0	12.00	34.00/0	wild squalls of high wind, flying clouds.
6	fair: some light snow.	7.15	27.00/0	12.00	37.00/0	cloudy, and intervals of moon light.
7	grey.	7.00	32.00/0	11.45	33.00/0	cloudy.
8	mild, thick, foreboding rain.	7.00	38.00/0	11.00	33.00/0	soft, and disposed to mist.
9	grey and foggy.	7.15	33.00/0	11.15	35.00/0	cloudy moon.
10	grey, inclined to rain.	7.00	34.00/0	12.00	45.00/0	mild rain.
11	mild rain; cleared up.	7.00	39.00/0	11.30	28.00/0	clear N. W. wind.
12	clear N. W.	7.00	19.30/0	12.00	16.30/0	clear, calm.
13	do. do.	7.15	15.30/0	11.15	26.00/0	snowing.
14	grey, barely done snowing: sn.	7.15	25.30/0	11.00	31.00/0	sleet and rain, hard rain.
15	threatening rain: rain.	7.00	34.00/0	11.15	23.00/0	N. W. wind very cold to the feeling.
16	grey, light snow.	7.15	22.30/0	11.15	22.30/0	grey, windy, threatening snow.
17	light snow, promising more.	7.15	21.00/0	11.00	19.00/0	fair star light.
18	threatening a fall of snow.	7.15	21.00/0	12.00	21.00/0	threatening snow.
19	do. do.	7.15	19.30/0	12.00	22.00/0	clear with northern light: calm.
20	calm and clear.	7.15	8.00/0	11.15	15.00/0	star light.
21	thick and cloudy.	7.20	31.00/0	11.15	40.00/0	rain and S. wind.
22	clearing.	7.20	32.00/0	11.45	30.00/0	calm, star light.
23	fair, sunshine.	7.30	29.30/0	12.00	35.30/0	hazy.

Nov.	Remarks before Noon.	h. m.		h. m.		Remarks after Noon.
24	grey, snow.	7. 25	30.30 / 0	11.35	31.30 / 0	thick and raw.
25	rain and southerly wind.	7. 10	43.00 / 0	11.40	22.30 / 0	high N. W. wind, and star light.
26	clear, moderate N. W. wind.	7. 30	9.00 / 0	11.45	15.30 / 0	calm, star light.
27	grey, calm, S. wind, changeable.	7. 15	24.00 / 0	11.15	31.00 / 0	overcast, threatening snow.
28	snow all day.	7. 15	33.00 / 0	11.30	31.30 / 0	light snow.
29	overcast, clear, sunshine.	7. 10	30.00 / 0	11.40	22.00 / 0	calm, star light.
30	hazy, foggy horizon.	7. 10	20.00 / 0	11.30	26.00 / 0	foggy, hazy, frost.

DECEMBER. 1791.

Dec.	Remarks before Noon.	h. m.		h. m.		Remarks after Noon.
1	grey, fair, cloudy.	7. 15	24.00 / 0	11.50	40.30 / 0	foggy, inclined to rain.
2	rain, mist, snow generally gone.	7. 30	39.30 / 0	11.30	30.00 / 0	clearing W. wind.
3	fair, a few flying cl. from W.	7. 30	24.00 / 0	12.00	20.00 / 0	fair, star light.
4	cloudy, threatens snow, snow.	7. 30	19.00 / 0	11.45	30.30 / 0	clear moon, a few flying clouds.
5	fair.	7. 35	26.30 / 0	12.00	24.00 / 0	snow 2 in. over the gen. surface.
6	clear, cloudy gathers. overcast.	7. 30	11.00 / 0	11.45	14.00 / 0	threatens snow, easterly airs.
7	snow.	7. 30	11.30 / 0	12.45	17.30 / 0	cloudy.
8	snow, 8 inches on gen. surface.	7. 30	13.00 / 0	11.45	13.30 / 0	snow.
9	thick, overcast.	7. 35	8.00 / 0	12.00	8.30 / 0	W. wind, overcast; severe all day.
10	do. do.	7. 10	8.20 / 0	12.00	14.40 / 0	grey, moon light, calm.
11	do. do.	7. 15	16.00 / 0	11.40	14.00 / 0	fine moonlight, cloudless sky.
12	hoar frost, and fog.	7. 20	16.00 / 0	12.00	29.00 / 0	sleet, sn. incl. to rain E. wind.
13	thick drifting snow, and sleet.	7. 30	28.00 / 0	11.40	31.00 / 0	snow all day, and N. E. wind.

DECEMBER. 1791.

Dec.	Remarks before Noon.	*h. m.*		*h. m.*		Remarks after Noon.
14	high W. wind and pouderic with flights of snow.	7. 35	16.00 / 0	12. 00	14.00 / 0	clearing W. wind, star & m. lt.
15	calm, clouds breaking fine.	7. 30	13.40 / 0	12. 00	22.00 / 0	calm and hoar frost.
16	overcast, clearing, sn.inc. to rain.	7. 40	26.00 / 0	11. 40	30.00 / 0	boisterous S. wind and clear.
17	calm, cloudy, sunshine.	7. 30	13.00 / 0	12. 00	15.00 / 0	calm, cloudy, some stars.
18	fine sn. grey & ovcst. hoar frost.	7. 30	12.30 / 0	12. 00	22.00 / 0	calm.
19	overcast, clearing.	7. 20	18.00 / 0	12. 40	13.00 / 0	overcast.
20	do.	7. 30	9. 30 / 0	12. 00	7. 30 / 0	thick, cloudy.
21	do.	7. 45	11.00 / 0	12. 00	13.40 / 0	drifting easterly snow.
22	N. E. wind, drifting fine snow.	7. 40	10.00 / 0	11. 50	12.00 / 0	high N. E. wind.
23	thick, light snow.	7. 40	6. 00 / 0	11. 30	12.00 / 0	light snow, thick.
24	fine, N. W. wind.	7. 30	3. 00 / 0	6. 00 12. 00	0 5. 30 / 0	fair, inclin'd to changeable.
25	thick snow.	7. 35	12.30 / 0	11. 55	15.00 / 0	snow all day, thick and overcast.
26	overcast and very mild.	7. 30	23.30 / 0	11. 50	34.00 / 0	high S. wind, star light.
27	high S. wind, fair & very mild.	7. 40	32.00 / 0	2. 00 11. 40	38.00 / 0 27.00 / 0	very fine mild star light.
28	mild S. airs, thick, very mild.	7. 30	33.00 / 0	3. 30 11. 55	38.00 / 0 27.00 / 0	gust of S. wind and rain for 10 minutes, high W. wind, thick and cloudy.
29	fine clear N. W. w. very keen.	7. 40	16.00 / 0			no observation.
30	cloudy, inclin'd to clear.	1. 45 7. 45	18.00 / 0 20.00 / 0	11. 30	15.00 / 0	calm, star light.
31	hoar fog.	7. 20	8. 00 / 0	11. 59	14.00 / 0	star light and calm.

JANUARY. 1792.

Jan.	Remarks before Noon.	*h. m.*		*h. m.*		Remarks after Noon.
1	grey, cloudy, snow all day.	7. 45	$\frac{12.00}{0}$	12. 00	$\frac{21.00}{0}$	snow, N. E. wind, calm, thick.
2	calm and thick.	7. 40	$\frac{21.30}{0}$	12. 00	$\frac{35.00}{0}$	sleety rain, rain from 6 to 10, thick and very mild.
3	mild wet slt. in flights, clearing high W. S. W. w. flights of r.	7. 50	$\frac{35.00}{0}$	12. 00	$\frac{34.00}{0}$	flights of rain & broken clouds, intervals of sun shine, high S. W. wind, thick & very mild.
4	thick and calm, clear sun.	7. 50	$\frac{26.00}{0}$	11. 50	$\frac{17.00}{0}$	star light, thick and calm.
5	fine, overcast and gloomy.	7. 45	$\frac{12.00}{0}$	12. 00	$\frac{29.00}{0}$	E. drifting sn. damp sn. & S. w.
6	high N. W. w. clear, pouderic.	7. 45	$\frac{4.00}{0}$	12. 20	$\frac{0}{8.00}$	keen N. W. calm. st. l. & fine m.
7	clear and calm, the Ther. not above 0 the whole day.	7. 30	$\frac{0}{15.00}$	11. 50	$\frac{0}{12.00}$	gentle airs from N. W. star and moon light.
8	grey all day.	7. 50	$\frac{0}{4.00}$			snow about 1 P. M. ther. $\frac{2.00}{0}$
9	grey moon.	0. 30	$\frac{2.00}{0}$	10. 50	$\frac{0}{5.00}$	clear N. W. airs, moonlight.
	grey, clear N. W. w. very keen.	7. 45	$\frac{4.00}{0}$			at 2 P. M. ther. at $\frac{18.00}{0}$ and
10	grey, calm and sunshine.	7. 45	$\frac{0}{14.00}$	11. 00	$\frac{0}{2.00}$	at 3 P. M. at $\frac{3.00}{0}$ clear and keen N. W.
11	fine calm western airs.	7. 48	$\frac{0}{1.00}$	12. 30	$\frac{4.00}{0}$	fine moon light.
12	fine.	7. 40	$\frac{0}{5.30}$	11. 15	$\frac{0}{5.00}$	some st. E. airs & haz. horizon.
13	thick, snow and easterly drifts.	7. 45	$\frac{10.00}{0}$	11. 30	$\frac{23.30}{0}$	snow, done snowing, overcast.
14	overcast, snowing.	7. 45	$\frac{28.00}{0}$	12. 20	$\frac{26.00}{0}$	snow all day till 7 P. M. thick.
15	th. clearing, fine & western airs.	7. 45	$\frac{20.00}{0}$	11. 00	$\frac{21.00}{0}$	thick and hazy.
16	overcast, fair mild day.	7. 40	$\frac{16.00}{0}$	11. 05	$\frac{14.30}{0}$	overcast S. W. wind.
17	overcast, inclined to snow.	7. 40	$\frac{10.30}{0}$	11. 20	$\frac{12.00}{0}$	overcast, calm.
18	clearing to the N. W. flights of very light snow.	7. 35	$\frac{5.00}{0}$	11. 20	$\frac{6.30}{0}$	calm, st. overhead, thick horizon.
19	gr. cle. fine N. W. w. s. shine.	7. 30	$\frac{1.00}{0}$	11. 45	$\frac{6.40}{0}$	fine all day, star light.
20	gr. a gleam of s. thick incl. to sn.	7. 30	$\frac{10.00}{0}$	12. 00	$\frac{5.30}{0}$	grey all d. st. l. & high S. W. w.

Jan.	Remarks before Noon.	*h. m.*		*h. m.*		Remarks after Noon.
21	clear and strong N. W. wind.	7. 30	0 / 3.00	12. 00	0 / 7.30	keen N. W. all d. calm st. light.
22	very keen, clear N. W. wind, fine s. & cloudless sky, thought the coldest day hitherto felt this season.	7. 30 9. 52 11. –	0 / 14.00 0 / 13.40 0 / 10.00	00. 52 3. 55 12. 00	0 / 6.00 0 / 6.00 0 / 15.00	very keen & clear all day, wind W. N. W. st. light & very cold.
23	N. W. wind and extreme cold, bright sun all day. Shuttleworth's F. Thermo. } 0 / 24.00	7. 15	0 / 20.00	00. 30 4. 45 12. 00	0 / 10.00 0 / 7.00 0 / 9.00	keen & clear all day wind N. W. keen clear star light.
24	high wind and clear moderate.	7. 30	0 / 8.00	8. 15 12. 00	4.00 / 0 4.00 / 0	high wind and northern lights.
25	clear and calm.	7. 20	0 / 2.00			
26	star light and calm. calm and clear.	1. 20 7. 33	0 / 2.00 0 / 7.00	11. 45	4.00 / 0	clouds gathering.
27	overcast—some beams of sun in course of the day.	7. 45	0 / 2.00	11. 00	7.00 / 0	cloudy and calm.
28	thick, overcast and calm, light sn.	7. 30	7.30 / 0	11. 45	12.00 / 0	light snow and overcast.
29	overcast, clear noon.	7. 35	11.30 / 0	12. 00	13.00 / 0	star light and calm.
30	hazy horizon.	7. 20	1.00 / 0	11. 25	17.00 / 0	hazy and calm.
31	snowing.	7. 40	23.00 / 0	4. 45 12. 00	28.00 / 0 30.30 / 0	snowing fast with East wind, wild high W. wind, snow and flying clouds.

FEBRUARY. 1792.

Feb.	Remarks before Noon.	*h. m.*		*h. m.*		Remarks after Noon.
1	overcast W. wind in squalls.	7. 30	25.00 / 0	12. 00	20.00 / 0	blustering W. wind, driving the fallen snow, wind moderating, but cloudy.
2	hazy, cleared towards noon with W. wind.	7. 20	19.00 / 0	12. 00	15.00 / 0	clear and star light.
3	grey, thick, fine mid day.	7. 40	12.00 / 0	12. 00	26.00 / 0	calm and thick.
4	grey, clou. breaks. in the N. W.	7. 35	33.30 / 0	3. 00	39.00 / 0	very warm, clear s. shine & calm.

XI. *Discoveries made in the Western Country, by General* PARSONS.

Middletown in Connecticut, October 2, 1786.

SIR,

THE frequent publications I have lately seen of accounts, said to have been given by me of my discoveries in the Western Country, many of them misrepresented, and some of them totally without foundation, induces me to execute a purpose I had long since entertained, of communicating to the Society for promoting Arts and Sciences in your state, such observations as occurred to me in my journey into that country, and the discoveries there made. It appears to me of consequence, that information of facts, which may tend to throw light upon any inquiries in the natural world, should be given to some literary society, where all facts and observations, being carefully compared, our reasoning on the subject may be with more certainty; and old principles confirmed, or new hypotheses established with more accuracy.

I left the settled parts of Pennsylvania the latter part of October last: and not to mention the large limestone springs frequently to be found in the county of Cumberland, sufficient to turn mills within a few rods of their issuing from the ground, and other curiosities I never saw before; about the 25th of that month, I passed the Allegany mountains, in the old Pennsylvania road. The ascent of about three miles

is

is gradual and easy. On the summit is a large extent of land comparatively plain. It is about eight miles from the top of the mount on the east, to the beginning of the descent on the west; whence to the level on that side is about two miles and a half. This extent contains almost all soils and descriptions of land; from the sandy pitch pine barrens and stony heath, where there is no apparent moisture; to as fine ploughland and luxuriant pasture and mowing, as I had before seen. On this mount are several mill streams, and springs of excellent water. It is observable, that the ascent of all those hills and mountains from the east, is greater than the descent on the west: and from the extensive grand view on the top of the mount, from which the country on the west and on the east is seen to a great distance, it is clearly discovered that the level of the country on the west, is vastly higher than the level on the east of the mountains. I had no instruments to determine the difference of those levels; but the fact is easily discerned by the eye. In travelling to this place, I observed the stones were pitched in the earth inclining to the horizon in angles of 30° or 40°; very few if any lay horizontally; and in general in a direction from the N. E. to the S. W: which is a circumstance I do not remember to have found on the west of that ridge of mountains.

I arrived at Pittsburgh the 30th, three hundred and twenty miles from Philadelphia. This is a place conveniently situated for carrying on the interiour commerce of that country. It stands on a point at the conjunction of the

Allegany

Allegany river (which extends about two hundred miles N. E. from this place) and the Monongahela; which in its meanders waters a country south eastward about three hundred miles. From this point begins the river Ohio, which after running in its serpentine course, more than eleven hundred and eighty miles, and receiving in its progress many large rivers from the east, and from the west, falls into the Missisippi in about Lat. 36° 40′. At Bedford, on my road to this place, I was informed by Col. Wood, of many curious discoveries lately made in the West Country: among others, that, in digging a cellar at a place called *Wheeling*, ninety seven miles down the Ohio, at several feet depth in the earth, was discovered a stone wall laid in *lime*. I arrived at *Wheeling* the 3d of November, and made strict inquiry into this account; and was informed by Mr. Zanes, an intelligent, sensible man, and one of the legislature of Virginia, that in digging for a cellar, not far from that place, had been discovered a wall some feet under the earth, very regularly laid up, apparently the work of art; but he knew nothing of the circumstance related of its being cemented with *lime*. From this, on the fourth, I went to Grave Creek, twelve miles down the river. Here is a mound of earth, plainly the work of mens' hands, called an Indian grave. It is of a conical form, in height about eighty feet. It ascends in an angle of about 45°. The diameter at the top is about sixty feet, the margin enclosing a regular concave, sunk about four feet in the centre. Near the top stands an oak, about three feet in diameter. I did

not open this grave, but proceeded down the river about sixty miles to the mouth of the Muskingum: near this river are the remains of an ancient fortress; a plan of which I find has been transmitted you by President Stiles. As this is the same I furnished him, it will be needless to attempt a more particular description of it. On the ruins of this work, has grown a white oak, now more than three feet diameter, which has an appearance of having sprung from the decays of a tree in the same place. This however, is conjectural, there not being so great evidence, as to render the fact certain.

After two days spent here, I proceeded on my journey about three hundred and eighty miles, without any extraordinary discoveries, to the great Miami. At the great Konahway and sundry other places, we found Indian graves similar to, but not as large as that at Grave Creek. Finding that the bones of a large animal had been discovered about thirty two miles from this station, curiosity led us to make search for them. Accordingly an excursion was made to the Big Bone Lick, the place where those bones were found. This place is a resort of all species of beasts in that country. A stream of brackish water runs through the land, which is a soft clay. About twenty acres are almost clear of trees, and are surrounded by higher lands. At this place were found, some on the surface, and some at a depth of four feet and more in the ground, the bones of the animal. An entire skeleton we did not find, but of different parts we brought off about four hundred pounds. A thigh bone

entire

entire measured forty nine inches in length. Parts of several jaw bones were found, but not an entire one. Some teeth were found in, and some out of the jaw, one of which I herewith send you. Part of a tusk we also had: two of the teeth I brought home; one, the corresponding tooth of the opposite jaw, is at Yale College: the other bone we boxed and left at Pittsburgh. Of this animal the natives have no tradition, but that which is so fabulous, that no conjecture can be aided by it; unless it be, that the animal was a carniverous one. It is observable, that the bones of this animal are only found near salt licks, and in low soft grounds.

In my progress further down the Ohio to the Rapids, nothing occurred worth communicating to your society; unless the petrifactions at the Rapids, and in sundry other places near the river, may be an object of attention. That elementary water does not possess this quality, I suppose to be an opinion too clear, to admit of objection. The greatest quantity of petrifactions, I saw, were at the falls. I was there when the waters were low, and the flat stones which extended across the river, and over which the waters generally flow, were bare, on both sides the river, as much as one fifth of a mile on each side. On the S. E. side, I observed no petrifactions. On the N. W. side, they were in great plenty, of almost every kind of vegetable production; and in every stage of the process, from their native state, to a perfect stone. Hornets' and birds' nests, nuts, roots, branches of trees, leaves, bones, &c. &c. were in great abundance.

ance.

ance. They appear at first, by accident, to be left resting on the stones; and the water exuding from the adjoining bank, falls gently on the stones; and glides almost imperceptibly over them, and brings with it some adhesive quality, which slightly fixes the resting body to the stone on which it lies; and an external incrustation is first formed around the body; whence the petrifaction is continued, till the whole mass becomes a perfect stone, retaining fully its original shape. It is evident, that the stone, on which these petrified vegetables are formed, is also a vegetable; and grows up about the resting body, until in some instances the stone perfectly covers it. We were obliged in many instances to make use of picks, to break the stone or rock to a depth of several inches, to sever the petrified body from it. Whether the matter possessing this petrifying quality is known, or can be discovered, and separated from other earth, so as to become useful as a cement or otherwise, I will not pretend to assert.

In this country I was informed, that pieces of earthen ware, the common utensils of a family, are often dug out of the earth, some feet under the surface; and at Muskingum, in digging the trenches for their pickets, a number of pieces and one entire brick, were found buried two or three feet deep. Not thinking it proper to open the mounds of earth, supposed to contain the bones of the dead, whilst the Indians were in treaty with us; I desired the commanding officer, to open them at the Miami, after the Indians had gone; and also left the same request at Muskingum, with an

officer

officer of learning, and great curiosity in his observations in the natural world: and to inform me of their discoveries; extracts of whose letters I herewith send you. The Indians have no tradition what nation ever buried their dead in the manner we discovered them. The trees on the Indian graves and ancient fortifications (of which there are great numbers in that country) appear to be coeval with the adjoining forests. On the whole, I am of opinion, that country has been thickly peopled, by men to whom the necessary arts were known in a much greater degree than to the present native Indians of that region: but I am transgressing my own system, and shall return to facts only, and let others form hypotheses. Among the Indian nations in general, I find an appearance of a radical similarity in language; but this is not universally true; the Huron, or Wyandot language, having no affinity to the Shawanese, Delawares, and other nations. I do not remember to have heard a single word in that language, which had the least affinity, in sound, with the words in other languages, expressive of the same idea. A few examples follow:

	Shawanese.	*Delawares.*	*Wyandots.*
Bear	Mauquah	Mough	Un-yeu-ech
Water	Nip-peh	Beh	San-doos-tea
Snake	Mon-na-too	Aukook	Kun-gun-see
Deer	Seck-thee	Au-tooh	Ske-nun-took
Nose	O-chau-see	We-ke-un	A-yonh-joh
Eye	Ske-sa-coo	Wus-kingd	Yau-pe-dah.

Among the tribes, there are as characteristick distinctions in features, size, and complexion, as between the French, Dutch,

Dutch, English, and other European nations; and no small difference in their manners and habits. The Shawanese are generally of a small size, rather elegant in their features, and a very cheerful and crafty people. Counselling among their old people, and dancing among their young men and women, take up a great part of their time. The *Delawares*, on the contrary, are a stout, robust people; have little of the vivacity of the *Shawanese*, and are more grave in their manners. They all agree in a firm belief of a supreme good spirit; and also in the existence of evil spirits; one the author of all good, and the other the cause of all evil: and also in a state of future existence.

I could not satisfy myself that there was among them any set worship paid to the Deity: except in some nations, *once*, and in others *twice*, in a year, a national feast was provided, to which the tribe is convened; and the chief, before they eat, makes a speech to them, in which the duties they owe to the Supreme Being, and to one another, are explained; at the close of their repast, he exhorts them to the practice of those duties; and the whole is ended with a solemn dance.

The customs prevailing in some of the tribes, bear an affinity to the customs prevailing among the Jews (perhaps the same, or nearly might have been practised in early times by other eastern nations.) Women in travail are removed from the residence of the family to a hut provided at a distance: when delivered, their food is carried to them, and deposited near their door, for a number of days. The par-

ticular

ticular number, I find, I have not entered in my journal. After a certain number of days are ended (during which the wife is excluded from society) she returns home with her infant; and at the end of forty five days, is covered under the same blanket with the husband.

A woman, when her courses are upon her, maintains a silence, touches none of the family, eats by herself and retires.

Divorces are voluntary: either party puts away, and takes another mate at pleasure; but until the husband or wife is put away, adultery is considered as a high crime. Among the *Ottoways,* it is punished, with biting off the nose of the woman. The children, on a divorce, are divided. Among some nations, if the number is uneven, the mother takes the greatest part.

If any useful inquiries can be aided by any things I have transmitted you, my intentions will be fully answered.

I am, Sir,

with great Respect,

Your obedient Servant,

SAMUEL H. PARSONS.

President WILLARD.

XII. *Barometrical Observations and Remarks, made during a Tour to Lake Champlain, by* JAMES WINTHROP, *Esq.* F. A. A.

THE barometer, used in these observations, was prepared each time; the mercury being discharged after every observation, for the convenience of transportation. As, in common barometers, the scale of inches is adjusted

to

to a mean height of the mercury in the tube, from which all the variations are measured; in this, the various height of the mercury is accurately measured from the surface of it in the cup. The inconvenience arising from this source is trifling; and always diminishes, as the area of the cup increases, in proportion to that of the bore of the tube. That every one may be able to ascertain the differences for himself, the diameters of the cup and tube shall now be exhibited.

Diameter of the cup in inches and decimals	2. 5.
Diameter of the whole tube	0. 45.
Bore of the tube	0. 3.

The observations were made only in the finest weather, when there was very little wind. The mean height of the barometer at Cambridge, in similar weather, is 29. 95.

August 1st, 1786, at half past nine in the forenoon, at Weathersfield in the state of Vermont, and at the high water mark of Connecticut river, the barometer stood at 29. 65. We immediately sat out for the top of Ascutney, a very high hill in that neighbourhood. Our horses were left three miles from the top. At one o'clock, after a fatiguing walk of three hours, we were on the summit of the hill. Barometer 27. 7.

August 5th, 1786, at Williamston, in Vermont, a quarter after nine in the morning, barometer 28. 1. This town is situated on the height of land between the Connecticut river and lake Champlain; about forty five miles from the former, and fifty from the latter. The ascent in general, is easy on both sides. The place of observation was about

fifty.

fifty feet higher than a spring, that sends its waters easterly into the White river; which falls into the Connecticut, about five miles below Dartmouth College, between Norwich and Hartford. Westerly this spring, by means of the Onion river, communicates with Lake Champlain.

August 7th, at ten in the morning, on the beach at Burlington bay on the east side of the lake, Lat. 44° 15′ N. about seventy miles southerly from St. John's, and thirty six northerly from Crown Point, barometer 29. 6.

August 8th, at 1h. 30′. P. M. on the banks of the Onion river, about thirteen miles westerly from Williamston, thirty seven easterly from Burlington bay, and forty three from the mouth of the river, barometer 29. 4.

The difference between the mean height of the barometer at Cambridge, and at each of the places, which have been mentioned, is set down in the following table, with the corresponding altitudes above the level of the sea, as taken from Martin's *Philosophia Britannica.* Vol. 2. p. 134.

	inches.	feet above the sea.
Connecticut river at the foot of Ascutney	0. 30	299
Top of Ascutney	2. 25	2031
Williamston	1. 85	1666
Onion river, 37 miles from the nearest part of the lake, and 43 miles from its mouth.	0. 55	514
Burlington bay	0. 35	342
Cambridge above the sea	0. 05	42. 5

R Weathersfield,

Weathersfield, in Vermont, is about one hundred and fifty miles from the mouth of the Connecticut. The descent of that river is therefore, about two feet to a mile on an average. No current is perceptible in the lake, as I am informed, till we come near St. John's; which is about two hundred miles from Quebec. This latter place, being near the upper part of the Gulf of St. Lawrence, may be considered as near the level of the sea. The descent of water then, is, by the preceding table, about twenty or twenty one inches to a mile. Burlington bay is separated from Onion river by a point of land. The mouth of the river is about forty three miles from the place, where our observation was made on the banks. The descent is, by the same table, one hundred and seventy two feet; which is four feet to the mile: yet the rapidity of its current is not so great, as to occasion any inconvenience in fording it in the summer season. The width of the river is generally, where we had an opportunity of seeing it, from twenty to thirty rods; and its depth, in the channel at the fords, about two feet.

On September the 22d, 1780, I made the following barometrical observations at the Grand Monadnock, a large mountain between the towns of Dublin and Jaffrey, in New Hampshire. At the foot of the hill, the barometer stood

at	28. 4	1395 feet above the sea.
Immediately above the woody region.	27. 0	2682
At the summit	26. 4	3254
Mean at Cambridge	29. 95	42. 5

The

The general estimate has been, that if the barometer were carried upward ninety feet, the mercury would fall one tenth of an inch; but in Martin's table, which I have followed, only eighty five feet are allowed to the first tenth.

Cambridge, August 23, 1786.

XIII. *A Table shewing the Probability of the Duration, the Decrement, and the Expectation of Life, in the States of Massachusetts and New-Hampshire, formed from sixty two Bills of Mortality on the files of the American Academy of Arts and Sciences, in the year* 1789. *By* EDWARD WIGGLESWORTH, D. D. F. A. A.

ON examination of the bills of Mortality, on the files of the Academy, it appears that the society are under obligation to a considerable number of gentlemen, in different parts of the commonwealth, for the attention which they have paid to this subject. Since their formula has been dispersed through the state, many gentlemen have communicated bills of their respective towns, or parishes, with a topographical description of the same, which will lead to an investigation of the natural causes, which produce them, whenever it appears that particular diseases are endemial to any places.

Returns have been made from towns, scattered along the sea coast, from Nantucket on the south, to Portland in Casco-bay, on the north east, and through the counties of Middlesex, Worcester, and Hampshire, in a western direction. From

Hingham,

Hingham, Ipswich, East Kingston, Dover, Portland, Edgarton, Waltham, Ashburnham, Brookfield, and Brimfield, they have been made for a long course of years. And though those, which have been made from other places, are for a shorter term; yet, as they are from places very distant from one another, it is presumed that the result, from a combination of the bills, will give a very just representation of the increasing population of this state and New-Hampshire, and the longevity of their inhabitants. At least, it will exhibit more authentick evidence on the last of these subjects, than has, as yet, been laid before the publick. Should there be any errour in the deductions, there will be at least an approximation towards the truth; and the table will give the probability, decrement, and expectation of life, among the inhabitants of this state and New-Hampshire, with more accuracy, than has yet been done. Any errours in the deductions may be corrected, by taking the present result for the basis of a new combination with the bills, that may hereafter be communicated.

The whole number of deaths on the bills is 4893, which happened at the following periods of life.

Under	5	years		1942
Between	5	and	10	236
	10		15	136
	15		25	425
	25		35	382
	35		45	349
	45		55	270
	55		65	270
	65		75	372
	75		80	185
	80		85	171
	85		90	103
	90		95	36
	95		100	16

From these elements the table is formed, by taking the number of deaths as the radix of calculation. This would have given the proportional numbers of persons living, and dying at every age, from the birth to the latest extremity of life, had the annual number of deaths been equal to the births. But by the bills it appears, that the births are annually double to the deaths. Therefore, the number of persons of each age, as given by the table, is less, than is actually in life together, from an annual excess of 4893 births. Consequently the expectation of life is less than just, especially in the early periods of life.

THE TABLE.

Ages.	Persons living.	Decrem. of life.	Expectation of life. yrs. dec.	Ages.	Persons living.	Decrem. of life.	Expectation of life. yrs. dec.
At birth	4893	1264	28.15	20	2365	43	34.21
1	3629	274		21	2322	42	
2	3355	188		22	2280	42	
3	3167	132		23	2238	42	
4	3035	84		24	2196	42	
5	2951	58	40.87	25	2154	40	32.32
6	2893	55		26	2114	38	
7	2838	47		27	2076	38	
8	2791	40		28	2038	38	
9	2751	36		29	2000	38	
10	2715	28	39.23	30	1962	38	30.24
11	2687	27		31	1924	38	
12	2660	27		32	1886	38	
13	2633	27		33	1848	38	
14	2606	27		34	1810	38	
15	2579	42	36.16	35	1772	35	28.22
16	2537	43		36	1737	35	
17	2494	43		37	1702	35	
18	2451	43		38	1667	35	
19	2408	43		39	1632	35	

Ages.	Persons living.	Decrem. of life.	Expecta. of life. yrs. dec.	Ages.	Persons living.	Decrem. of life.	Expecta. of life. yrs. dec.
40	1597	35	26.04	70	698	37	10.06
41	1562	35		71	661	37	
42	1527	35		72	624	37	
43	1492	35		73	587	38	
44	1457	34		74	549	38	
45	1423	27	23.92	75	511	37	7.83
46	1396	27		76	474	37	
47	1369	27		77	437	37	
48	1342	27		78	400	37	
49	1315	27		79	363	37	
50	1288	27	21.16	80	326	35	5.85
51	1261	27		81	291	34	
52	1234	27		82	257	34	
53	1207	27		83	223	34	
54	1180	27		84	189	34	
55	1153	27	18.35	85	155	21	4.57
56	1126	27		86	134	21	
57	1099	27		87	113	21	
58	1072	27		88	92	20	
59	1045	27		89	72	20	
60	1018	27	15.43	90	52	8	3.73
61	991	27		91	44	7	
62	964	27		92	37	7	
63	937	27		93	30	7	
64	910	27		94	23	7	
65	883	37	12.43	95	16	6	1.62
66	846	37		96	10	5	
67	809	37		97	5	3	
68	772	37		98	2	1	
69	735	37		99	1	1	

The whole number of inhabitants, according to this table, is 140182; of which 48183 are persons under 16 years of age; and 91999, above sixteen years of age. By the enumeration

meration of the inhabitants of Massachusetts, the whole number of free males under sixteen was 95453; and 87189, above sixteen. Therefore, 35851 persons under sixteen, must be added to those in the table under sixteen, to make the table accord with the enumeration; which will give 176033 inhabitants, produced by an excess of 4893 annual births. This addition will raise the expectation of a child just born, from 28 years and $\frac{15}{100}$ to 35 years and $\frac{47}{100}$; of a child of 5 years of age, from 40 years $\frac{87}{100}$ to 48 years and $\frac{46}{100}$; of a person of 10 years, from 39 years and $\frac{23}{100}$ to 43 years and $\frac{23}{100}$; of a person of 15 years, from 36 years and $\frac{16}{100}$ to 36 years and $\frac{50}{100}$.

The annual excess of 4893 births above the deaths, on a stock of 176033 inhabitants, determines the period of duplication to be twenty five years and three tenths of a year. At this rate, the inhabitants of the five New England states are probably increasing at this time by natural population, without any consideration being had either to foreign or American accessions.

Similar bills, kept in the other states with the same accuracy that they have been kept here, would determine their natural population, with a degree of accuracy, which would be of utility to the publick; and would afford entertainment to persons of a philosophical disposition, both in Europe and America.

XIV. *An Account of a Curious and Singular Appearance of the Aurora Borealis, on the* 27th *of March* 1781, *by* CALEB GANNETT, ESQ. F. A. A.

THE Aurora Borealis is a phenomenon, which, though of great antiquity, if not observed by the first inhabitants of the earth; yet a satisfactory cause of it has never been assigned. Its region has been generally supposed that of the clouds. A greater elevation however has by some observers been suggested. Could sufficient data be obtained to ascertain its height, possibly it might be of great use in an attempt to investigate the cause. These data must be expected from repeated and careful observations of the aurora, and the several circumstances attending it, at different times. With this view is offered the following observation of an uncommon, and curious appearance of the aurora in the evening of the 27th of March last.

Mr. Mellen, the Philosophical Tutor in the University of Cambridge, being abroad in the beginning of the evening, gives the following account; that a dusky vapour, appearing like a cloud, lay extended along the horizon from N. N. W. to N. E. Its upper edge was uneven and changeable. Above it was a body of light, strong and vivid, which emitted streams of a pale colour, but bright, long, and frequent. About half past 9 o'clock, there arose nearly in the east, a column of steady light, inclining considerably to the south. From the upper side of this column, the light soon began to issue, not in flashes or streaks, but rather in a sheet

like

like smoke driven by the wind. Its direction was towards the zenith; and in a little time, crossing the meridian, it joined a column of fainter light; which formed in the west soon after the forementioned column in the east. This ring or zone was at first faint, except where it began; but continued to grow brighter, till the stars, which were observable through it, were much obscured. At 20 minutes past ten, I first saw it; when its brightness began to diminish, and its situation was as follows. Its eastern extremity was very near the east point. The northern limit crossed the meridian at 20° S. of the zenith. Its western extremity was bounded by Aldebaran, whose height was 5°. Its breadth increased gradually from the east and west limits, to its meridian height, where it was 5° as determined by two stars on the Lion's hip, which were near the meridian, and bounded the zone on the north and south. Denel was on the south limit. A star of the second magnitude in the Lion's shoulder, was just within the northern limit. Vindemiatrix appeared in the middle of the zone, and Pollux, a little without the northern limit. It moved slowly towards the south, gradually decreased, and disappeared entirely by 11 o'clock.

In the Transactions of the Royal Society in London, is an account of a similar phenomenon, observed in Geneva, by Mr. Cramer, in 1730. The zone was terminated by two parallel arches; and was diametrically opposite to the middle of the aurora borealis. The aurora and zone seemed much nearer one another in the horizon, than in the top. Supposing this difference entirely optick, and the parallelism of the two circles

real, the distance of the phenomenon from the earth, he says, might be computed. He however cannot admit the supposition, because the conclusion would be, that the phenomenon would have been distant at least $\frac{1}{24}$ of the diameter of the earth, which is too great an altitude to believe. He had previously offered a conjecture, respecting the production of the zone, viz. from icy particles swimming in the air, and of such a figure, as to exhibit a great zone by the reflection and refraction of the light of the aurora, almost in the same manner as the drops of rain produce the appearance of the rainbow. Whether this hypothesis, incompatible with the forementioned conclusion, on account of the rarity of the atmosphere at that height, which renders it incapable of sustaining particles, whose specifick gravity should be such as to cause the reflections and refractions necessary for such a phenomenon, might not bias his judgment, may be questioned. He mentions two arches, rising from the east and south east, meeting in the meridian, immediately afterwards parting, drawing back, and frequently repeating those motions. These arches must be supposed to originate from the same cause with that of the zone; but whether their motions agree with the cause conjectured, every one will judge.

Mr. Professor Greenwood, in an account of an aurora borealis, observed by him at Cambridge in 1730, affirms, that this meteor has been observed in New England at different times, ever since its first plantation; which is contrary to the commonly received opinion, that it is of modern date in this part of the world. Its appearance however,

was

was less frequent at the first settlement, than in the Professor's day. Perhaps, on examination, it will be found, that as the country has been cleared, the frequency of the phenomenon has increased. An uniform ratio however is not pretended. Future attention of the curious to this subject, will, it is hoped, enable them to give a solution of what has generally been supposed a mystery; and with which imagination has, in some instances, played not less fantastically in the eye of reason and philosophy, than is common for the phenomenon itself to do in the view of a spectator.

XV. *Letter on the Darkness in Canada, in October,* 1785. *From the Honourable* WILLIAM HEATH, ESQ. F. A. A.

Roxbury, December 30th, 1785.

SIR,

HAVING from the commencement of the American war, to the present time, kept a journal of occurrences, and for a number of years past, added thereto remarks on the seasons, weather, &c. on observing in the publick papers an account of the phenomenon, in the Province of Canada, on the 9th, 15th, and 16th, of October last, I was led to examine my journal for the state and appearance of the atmosphere at this place, on each of the days before mentioned; by which I find, that on the 9th of October, the wind was part of the day southeast, and the other part southwest, the weather fair, cool, and pleasant; the 15th, wind easterly, the atmosphere foggy. About two o'clock, P. M. it began to

grow

grow uncommonly dark, which continued to increase for some time, during which the atmosphere exhibited a yellow hue; a few drops of rain fell, and there were several very heavy claps of thunder at a distance to the northwest; the wind at this time shifting to different points almost round the compass, in a very short time. As the darkness diminished, the sun became visible through the fog, looked red, and to appearance resembled the full moon at night, in the month of May. In the evening the wind was southerly; the 16th, wind southwesterly, fair, warm, and pleasant.

Comparing the foregoing, with the state of the atmosphere in Canada, as described in the late publications, is it not probable, that the large quantities of exhalations and vapours, with which it was charged on the 15th, and which apparently extended from Canada to this place, were by the southwesterly wind, on the night of the 15th, driven northward, and being opposed by a northeasterly wind, such an abundance were forced together, over Quebec, and other places in Canada, as from the state of the atmosphere, and vaporous particles, extended to such an height, as to occasion the darkness in that quarter, and by condensing, descended in the heavy showers mentioned; and had the northeasterly wind prevailed against the southwesterly, the darkness might have been in New England on the 16th? But of this the learned and curious in meteorological observations, can better determine; and is humbly submitted to your Excellency.

I have the honour to be,

with the greatest respect,

Your Excellency's

most obedient servant,

W. HEATH.

His Excellency JAMES BOWDOIN, *Esq.*

Some Particulars of the Phenomenon in the Province of Canada, in the Month of October, 1785, *as published in the Independent Chronicle, at Boston, December* 22*d.*

Quebec, October 20th, 1785.

"ON Sunday the 9th instant, between four and five in the afternoon, an uncommon darkness was perceived here, though at the same time the atmosphere over this city appeared of a fiery, luminous, yellow colour: this was followed by squalls of wind and rain, with severe thunder and lightning, which continued most of the night, a thing uncommon here at this season, it having froze considerably the night before."

"On Saturday the 15th, about fifteen minutes after three in the afternoon, it became darker than it had been the Sunday before, and the sky of much the same colour; it was succeeded by a heavy shower, and very severe thunder and lightning."

"Sunday morning the 16th, was quite calm and foggy, till about ten o'clock, when there arose some wind from the eastward, which partly expelled the fog: in about half an hour after it became so dark, that ordinary print could not be read within doors: this was followed by a squall of wind and rain, when it brightened up again. From five till ten minutes after twelve, the darkness was so great, that the ministers in the English and Presbyterian churches were obliged to stop till they got candles. From two o'clock, till about ten minutes after, it was as dark as midnight, when there is no moonlight. From forty three till about fifty minutes

after

after three o'clock, it was total darkness; and from thirty five till forty five minutes after four, it was very dark. The people in this city dined by candle light; and spent a part of the afternoon in lighting up, and extinguishing them. Each period of darkness was followed by gusts of wind and rain, with some severe claps of thunder, and the atmosphere looked as before described. It was remarked, that on the days before mentioned, there appeared to be two adverse currents of air, the uppermost impelling a luminous strata of clouds towards the N. E. and the lower driving with great rapidity broken misty clouds towards the S. W. and that the rain water which fell on Sunday during those gusts, was almost black."

Montreal, October 20th.

"ON Sunday the 16th instant, the air was darkened by a thick fog, which dissipated about ten o'clock. The atmosphere was of a luminous, fiery colour. About two o'clock in the afternoon, it became dark by degrees, in such a manner, that about half an hour after two, people could not see one another in the houses. This lasted twenty minutes, and was followed by lightning, thunder, and rain, which gradually diminished the darkness: it was however, very difficult to read without candle light at three o'clock. This period was of short duration, for the darkness came on again at seven minutes past three; and it grew by degrees as dark as before, insomuch that no night ever was more obscure than it was at this time. The black clouds dispersed about fourteen minutes past three; but lightning, thunder, and a heavy rain continued till about half after five."

It

It is said, that just after the total darkness at Quebec, "a large ball of fire fell into the river, near a large ship, which was seen by many: It caused an uncommon agitation in the water."

W. HEATH.

XVI. *Observations on Trees, as Conductors of Lightning. By Mr.* HUGH MAXWELL.

Heath, June 21st, 1787.

SIR,

I HAVE no manner of doubt, but that your Society will very readily attend to every kind of information that is designed to propagate useful knowledge; and as freely to answer every honest inquiry, although from ever so obscure a quarter. And I hold it a duty incumbent on every person to offer such communications; and to make such inquiries as may tend to serve the publick.

I have observed, that the lightning often strikes the Elm, the Chesnut, every species of the Oak, and Pine, and sometimes the Ash, with many other sorts of trees: but I cannot recollect, that I have ever seen the Beech, the Birch, or the Maple, struck by lightning. I have made inquiry among the small circle of my acquaintance; and I cannot find, that any person has ever observed the effect of the lightning on these sort of trees. Now, sir, if this is really the case, that the lightning does not touch the Beech, the Birch, or the Maple (as I think it to be) then the question will a-

rise

rise in my mind, whence the reason of it? Is it from the shape and form of the tree? Or, is it in the nature and quality of that sort of wood, to resist that which has been judged by many to be irresistible? Or, do those trees conduct the lightning, without any injury to themselves? If it should appear, that those trees are not liable to the stroke of lightning, and the reasons appear, why they are not, then perhaps, it may be of service to erect our buildings in whole, or in part, with these sorts of timber. But I must leave the improvement of the hint to the gentlemen of your Society for propagating useful knowledge. And if the same, or similar observations have been made by others, I have this consolation, that my intent in this is to serve my country, which fully rewards

your most obedient,

and very humble servant,

HUGH MAXWELL.

His Excellency JAMES BOWDOIN, Esq. F. A. A.

XVII. *Experiments in Electricity.* *By Mr.* JOHN VINALL.

Boston, May 23d, 1790.

SIR,

IN making use of my large electrical machine, which is constructed with both a positive, and a negative conductor, the air being humid, and consequently unfavourable for electrical experiments, I made use of a small iron pan with some coals under the machine, in order to qualify the surrounding atmosphere, so as to answer my purpose.

By

By accident I burned my thumb with the pan so much, as to cause me great pain. Knowing that in some instances, I had been relieved of slight burns, by holding the part affected to a common fire, I held my thumb a small distance from the *negative* conductor; put the machine in motion; and to my surprise, found that in a few seconds of time, the effects of the burn were destroyed; my thumb perfectly at ease; and no blister arose, as would have been the case if I had not made use of electricity. I met with a similar instance not long after: I made use of the same remedy, and received the same benefit.

A few weeks after this discovery, one of my daughters scalded her arm from her wrist to her elbow, with the steam from a tea kettle, which produced a great inflammation upon the part, attended with much pain; and it is highly probable a blister would have succeeded. I desired her to hold her arm to the *negative* conductor; and in a few minutes, the pain ceased, the redness subsided, and her arm was perfectly cured.

I never read, or heard of an experiment of this kind being made in electricity: Therefore, I esteemed it my duty to lay it before the Academy of Arts and Sciences, that gentlemen might be induced to make experiments from this hint, which may be of great service to mankind, and an improvement in *medical electricity*.

I have the honour to be, with sentiments of esteem,

Sir,

your obedient humble servant,

JOHN VINALL.

Hon. JAMES BOWDOIN, ESQ. *President of the American Academy of Arts and Sciences.*

XVIII. *Observations on the Effects of Light on Vegetation. By Hon.* JAMES WARREN, ESQ. F. A. A.

Milton, January 25th, 1786.

GENTLEMEN,

THE investigation of the economy of plants is a subject of universal importance to mankind; and has accordingly engaged the attention of the philosopher, as well as the husbandman. But, from the intricacy that attends it, it has hitherto disappointed the researches of the first, and the observations of the last, at least in the most useful and material questions; among which I think are, What is the food of plants? In what manner is it received into their vessels? And how it operates, to produce such benefits to man and other animals? These are yet subjects of discussion and dispute; and are advanced no farther than the conjectures of those, who hold different sentiments on different systems which they have adopted; each of which is far from establishing that decision, which can lead the practical farmer to a certain and successful process in cultivation. We know, in many instances, that light has a great influence on the growth of plants; and perhaps, they cannot subsist without it. But this is a general provision of nature; and can receive but little addition from the industry of the husbandman. It seems to be rather a *sine qua non,* than a discovery of the *desiderata* we wish for. However, it is difficult, if not impossible, to conclude, that an instance of the effect of light on vegetation may not, in some cases,

lead

lead to a solution of the above questions. I therefore, beg leave to communicate an extraordinary instance, related to me by a gentleman of undoubted veracity in my neighbourhood. The account is as follows: On going into a cellar, which he used for the preservation of roots in the winter, and kept close and dark, he discovered, in the south east corner, a very small hole, which admitted a little light; and that a vine proceeding from a potatoe, accidentally left in the north west corner, had pursued a direct course to the aperture in the wall; and after running twenty feet on the cellar floor, ascended the wall, and without any deviation in its whole course, went out at the hole. This is the strongest instance of the effect of light on the growth of plants, that has fallen under my observation; and being so extraordinary, will, I hope, apologize for this communication, if it produces no other effect, than amusement to the curious.

I am your obedient,

humble servant,

J. WARREN.

To the AMERICAN ACADEMY *of* ARTS *and* SCIENCE.

XIX. *A Letter concerning Gay Head. From the Reverend* SAMUEL WEST, D. D. F. A. A.

Dartmouth, October 9th, 1786.

SIR,

YOUR Excellency undoubtedly remembers, that I was appointed by the Academy to be a committee, to examine the mineral productions of Gay Head, and to submit

mit them to a chemical analysis. I invited Dr. William Baylies of Dighton to be my assistant.

On the 28th of June last, Dr. Baylies, Col. Pope, myself, and two others, visited the Gay Head, with a view to make what discoveries we could. Dr. Baylies has drawn up a very full account of the voyage, and the principal curiosities, which we saw. He has given me liberty to transmit his account to the Academy. His letter has superseded many observations, which I otherwise should have made.

The inhabitants presented us with a petrified bone, said to be one of the vertebræ of the whale, which they told us they found in the cliff: It is very heavy, owing, I apprehend, to a metallick impregnation. They also brought us two shell fish, which were petrified: These were taken out of the cliff. There are many signs of a volcano, which the Dr. has accurately described. The Dr. and I dug out some pieces of charcoal at the bottom of the cliff, the height of which we judged to be an hundred and fifty feet. Some of the pieces seem to be charred more imperfectly than others. Some of the vitriolick springs are very strongly impregnated with the taste of copperas; others have more of an aluminous taste. We found in the cliff many efflorescences of copperas: These green efflorescences were always in a bed of blue clay. We found a white crumbly earth, interspersed with white shining particles. These shining particles melt in a moderate heat and soon calcine. I suppose them to be of the gypseous kind. The Dr. observes

in

in his letter, that "we found hard heavy pieces of matter, sparkling with small granulated particles of a white colour imbedded therein." Judging that this substance from its specifick gravity, must contain in it something metallick, I determined to submit it to a chemical analysis. With this view, having reduced some of it to powder, I went to a goldsmith, and desired him to assist me in examining this substance. The matter being put into a crucible with some saltpetre, in a moderate heat, we perceived a sulphurious smell. We raised at length a pretty strong red heat. A strong smell of sulphur continued, until it was succeeded by a pretty strong arsenical smell. When we had driven off all the sulphurious and arsenical fumes, we found nothing left but a little black cinder. Upon this I concluded, that the sulphur and arsenick had volatilized all the metallick parts. I then took the matter being reduced to powder, and having washed away the earthy and strong part, I submitted the residuum for some hours to a gentle torrefaction. Judging that I had sufficiently volatilized the sulphur and arsenick, I took the matter and put it into a crucible with some salt petre and tartar; and after having kept it a considerable time in a strong red heat, the matter was taken out, and we found a metallick button in the bottom of the crucible. The lower part of the button was somewhat whitish in appearance; and the upper part, of a reddish hue. It soon tarnished in the air, and became all over a dusky colour. It was hard and very brittle, not having the least degree of malleability in it. The quantity was about a fifth of the matter, which we put into the crucible. I

judge

judge it to be sulphurated iron mixed with copper or some other metal; for it appeared to be slightly attracted by the magnet, which is an evident proof that a considerable part of it must be iron. In addition to what the Dr. has observed, that there must formerly have been a volcano on the Gay Head, I would inform your excellency, that an elderly man, who was in company with us, told me, that his mother had informed him, that she could remember when it was common to see a light upon Gay Head in the night time. Others informed me, that their ancestors have told them, that the whalemen used to guide themselves in the night by the lights that were seen upon Gay Head.

I desire your Excellency would communicate my letter, together with Dr. Baylies', to the Academy, at the next meeting. I am with great respect,

your Excellency's most obedient,

humble servant,

SAMUEL WEST.

His Excellency JAMES BOWDOIN, *Esq.* F. A. A.

XX. *Description of Gay Head. By Dr.* WILLIAM BAYLIES, F. A. A.

Dighton, July 1st, 1786.

SIR,

I HAVE, at length, executed the design, which I had formed, in consequence of an invitation from the Reverend Mr. West, of visiting Gay Head. In company with him, Col. Pope, and two others, I sailed from Bedford, in an

open

open two mast boat, early on Wednesday morning. A northerly wind carried us down the river into the midst of the bay, in an easy, agreeable manner. A calm then coming on, with a hot sun, and a constant rolling of the boat, I grew exceedingly sick. Nothing could alleviate my disagreeable feelings, but a view of Gay Head, through Quick's Hole, at the distance of about fifteen miles. A variety of colours, such as red, yellow, and white, differently shaded and combined, exhibited a scene, sufficient to captivate the mind, however distressed. In about two hours, a fresh breeze sprung up from the southwest. This obliged us to run west, to take the advantage of an opening between two of the Elizabeth's islands, several miles above Quick's Hole. On entering this, the Vineyard sound was full in sight, at about a mile a head. There the waves were very high and boisterous; and contrasted with the smoothness of the waters in the bay, formed rather an object of terrour. But we soon passed it in safety; and landed on the north side of Gay Head, about a mile to the east of its northwest extremity. This we did to avoid the rocks. We beckoned to two young Indians, whom we saw on the hills above us. They immediately came; and, by the promise of a little rum, our boat was hauled up on the beach; the stores unloaded, and carried to an Indian house. Thither we followed; where I proposed refreshing myself with a dish of tea. Col. Pope joined me; but Mr. West's curiosity carried him directly on to the cliffs. During our repast, our landlord informed us, that Gay Head was between three and four miles in length, and two in breadth: and was almost

most separated from the other part of Martha's Vineyard by a large pond. The Indians inhabiting this part, when lately numbered, amounted to two hundred and three. The land produced Indian corn, rye, potatoes, peas, flax, and beans; but in small quantities, since the British General Gray deprived them of their sheep, which animal greatly enriched their soil. They now had recourse to the whites, on the east end of the island, for a supply of bread corn. Their cattle were almost starved through the winter; and of course, gave but little milk in the summer, though furnished with a plenty of sweet feed. They burned nothing but bushes, this part of the island affording no wood; and suffered much from the cold in the winter, though peat was procurable in plenty. As to religion, they were divided between the congregational and baptist persuasion: an Indian of the latter preached to them every sabbath; but they were seldom favoured with a congregational teacher. After our refreshment, we made for the cliffs. In our way, we found the soil to be good; wanting nothing but industry and proper management to render it capable of producing every kind of vegetable in perfection. It was rather light and dry, consisting of a greyish sand, and vegetable mould, two feet or more in depth, intermixed with portions of a darker coloured earth. It manifests to the taste a strong impregnation of the vitriolick acid; and contains many bright shining particles. Underneath this to a level with the sea, it is made up of a mixture of ochrey, sandy, stony, marly, and loamy earth, tasting also of the vitriolick acid. The water seemed to be tolerable; one spring

in

in particular, had nothing disagreeable or foreign in its taste, but on the contrary was quite sweet and palatable.

After our arrival at the cliffs, we looked round for a place of descent. This, in a little time, we found. But, I must confess, I proceeded on with great caution, and some fear; knowing that one false step would bring me to the bottom much sooner than I could wish. On one side, we had a red, unctuous, argillacious earth; on the other, a blue, white, and yellow one, variegated with grey, black, and green spots, and masses of charcoal under our feet. When we had descended, on looking back, the idea of a volcano struck us at once. In fact, it had all the appearance of having blown out but a few days. That it was formerly a volcano, was confirmed by a further examination. Large stones, whose surfaces were vitrified; great numbers of small ones, cemented together by melted sand, and also cinders were to be seen in many places. A black, sooty, powder, similar to lamp black, and made use of by painters to serve the same purposes, under which a whitish matter resembling the gypseous earth calcined intermixed with the same kind of earth uncalcined, were to be found in great quantities. Besides, there are very plain marks of four or five different craters. The most southerly, and perhaps, the most ancient, as it is grown over with grass, now called the Devil's Den, is at least twenty rods over at the top, fourteen and a half at the bottom, and full one hundred and thirty feet at the sides; except that which is next the sea, where it is open. Add to this, a tradition prevalent among the natives: In former times, the Indian God, Moiship,

resided in this part of the island; and made the crater, described above, his principal seat. To keep up his fires, he pulled up the largest trees by the roots; on which, to satisfy his hunger, he broiled the whale, and the great fish of the sea, throwing out the refuse sufficient to cover several acres. He did not consume all himself; but with a benevolent hand, often supplied them with food ready cooked. To facilitate the catching these fish, he threw many large stones, at proper distances, into the sea, on which he might walk with greater ease to himself. This is now called the Devil's bridge. On a time, an offering was made to him of all the tobacco on Martha's Vineyard, which having smoked, he knocked the snuff out of his pipe, which formed Nantucket. When the Christian religion took place in the island, he told them, as light had come among them, and he belonged to the kingdom of darkness, he must take his leave; which, to their great sorrow, he accordingly did; and has never been heard of since.—Had this been a Grecian or an Egyptian fable, how many volumes of explanations, resolutions, and comments, it would have given rise to!

We tarried on the island till between twelve and one o'clock the next day, walking round, ascending, descending, and examining the cliffs. We reckoned they were about a mile and a half in extent, and in height 150 feet. They appeared to be composed principally of clays, of all colours, and unctuous to the touch. The red, used as a paint, undoubtedly derives its colour from the calx of iron. The blue shoots out copperas in considerable plenty; and we

found

found hard heavy pieces of matter, sparkling with small granulated particles of a white colour, imbedded therein. This, it is probable, will afford something of the metallick kind. There were also other large heavy pieces of a reddish colour, resembling manganese. Small streams of water ran down the sides of the cliffs, more especially in the morning; every one of these had more or less of the vitriolick taste.

The bones of whales, sharks' teeth, and petrified shell-fish, are frequently picked up, scattered up and down the cliff, at a considerable distance above the surface of the water.

The sea, it is said, has made great encroachments on this part of Gay Head. Within thirty years, it has swept off fifteen or twenty rods. Had Neptune thus demolished part of Vesuvius or Ætna, up to their very craters; and laid open all their secrets, how would the curious in Europe have flocked from all quarters to behold a scene so full of wonders! But Gay Head is scarcely mentioned in America.

The wind being favourable, we launched our boat; and run, against the tide, to Bedford, thirty miles at least, in three hours and a half.

I am,
with great respect,
your humble servant,
WILLIAM BAYLIES.

To the President of the Academy.

XXI.

XXI. *List of Forest and other Trees, Northwest of the River Ohio. By* WINTHROP SARGENT, ESQ.

Boston, January, 1787.

MR. Sargent does himself the honour of presenting to his Excellency Governour Bowdoin, the President of the Academy of Arts and Sciences, a brief descriptive list of the forest and other trees, N. W. of the river Ohio to the latitude of 38°. They are not well arranged, but in the same order in which they fell within his observations; and were noted merely for comparison with the woods east of the Allegany Mountains, and for his own private satisfaction. A suggestion from one of his friends, that this list may possibly contribute to the natural history of North America, induces him to offer it to his Excellency with most respectful compliments.

Oaks: Spanish, Black, White, and Chesnut Oaks, from eighteen inches to six feet diameter; Swamp White Oak, from twelve inches to five feet; and Black Jack Oak, to two feet; another species of White Oak, not large, smooth bark and bearing a sweet acorn: two feet diameter is the largest.

Yellow and White Poplar, six and eight feet diameter, and very lofty. Canoes of seventy feet length, and five feet breadth, are made of them, and capable of transporting thirty five horse load of skins.

Elms, of six feet diameter.

Sugar Tree or sweet Maple, of five feet diameter; very beneficial to the country, as great quantities of sugar and

almost

almost sufficient for the consumption of the people are made from the juices of these trees. Curled Maple, to five feet diameter.

Sycamore, from two to fifteen feet diameter; and the larger kind always hollow to ten or eighteen feet, and from thence separating into two or three limbs or branches.

Black Walnut, from two to six feet diameter. White Walnut or Butternut, from two to four feet diameter.

Cherry Tree, from two to five feet.

Black Ash, three feet diameter. White Ash, to five feet diameter. Hoop Ash, of three, and three and a half feet diameter.

Chesnut, from one to six feet diameter.

Black Hickory, with a small thin shell nut, and from one foot to five and a half diameter. White Hickory produces a small bitter nut, eaten only by the turkeys, and is from one to four feet and a half diameter, and excellent rail timber. Shell Bark Hickory produces a very fine long nut of one inch and three quarters, and is from one to five feet diameter.

Sassafras, from bushes to trees of three feet and a half, and in use for canoes.

Honey Locust or Jerusalem Thorn, from six inches to three feet, armed in the trunk and limbs with sharp thorns, and producing a sweetening very proper for beer, as it causes immediate fermentation. The Black Locust is a very durable wood, and in use for pins and gate posts; grows from six inches to two feet and a half diameter.

Beech

Beech produces a small nut in high esteem, and grows from one to four feet diameter.

Spruce Pine grows on cliffs near heads of waters, and is of the same qualities with the northern Beer Spruce; it is from one to three feet diameter. White Pine grows lofty, and to three and four feet diameter, but not in plenty. Pitch Pine, to three feet diameter, and producing tar and turpentine.

Red Cedar, of two feet diameter. White Cedar, eighteen inches.

Buck Eye or Horse Chesnut, of three feet diameter, and producing a bad nut.

Lynn, of three feet and a half diameter, a light white wood very proper for finishing the inside of dwelling houses. Cucumber Tree, of two feet diameter, a soft light wood, which may be applied as Lynn.

Here is a tree very much resembling the Sumach, growing tall, and to two feet and a half diameter. Sumach grows single, generally to eight inches diameter, and thirty feet high, producing abundance of berries.

Gum Tree, which is applied for wheel naves, is of three feet diameter.

Black and Yellow Birch, to two feet diameter. The bark of the latter is used by the Indians for making canoes.

Iron Wood, close and firm, to fifteen inches diameter.

Dog Wood, of twelve inches diameter.

Aspen Tree, two feet diameter.

Box Elder, from six inches to two feet, and a very crooked tree.

Mulberry

Mulberry Trees, growing on bottoms and rich uplands, eighteen inches diameter.

Crab Apple Trees, producing very plentifully of small fruit, and growing from six to fourteen inches diameter.

A variety of Plumb Trees, growing from seven to eight inches diameter, and bearing fine fruit.

White Thorn, very plenty, in the low grounds of creeks and cold land, from four inches to twelve in diameter.

Black Haw, four inches diameter, and producing good fruit. Red Haw.

Papaw, from six feet to twenty in height and six inches diameter, growing on rich shaded bottoms and north sides of hills, in best lands, and producing a most luscious fruit, in bunches or clusters of threes and fives, resembling cucumbers of about four inches, except that the ends are more round. They have in them seven large seeds, of the bigness and colour of tamarind stones, and the leaves of the tree are very large, long, and like an inverted spear.

Service Trees, to twelve inches diameter, and producing a red fruit of the berry kind, much admired by the bears, and for which they are very often broken down by those animals.

Hazel, Alder, Elder, Large Laurel, Nine Bark, Spice, and Leather Wood Bushes. Leather Wood bark is an excellent substitute for cord, answering on many occasions (particularly in packing) all the purposes of hempen strings: it grows only in low and very rich lands.

XXII.

XXII. *Account of a Skeleton of a Large Animal, found near Hudson's River. By the Rev. Mr.* ROBERT ANNAN.

Boston, December, 1785.

SIR,

The following Narration was drawn up, soon after the discovery therein mentioned, was made. But my removal from the State of New-York to this town had so deranged my papers, that, for a long time, I was afraid it had been lost. If you think it worthy a place in your curious collections, it is at your service.

ROBERT ANNAN.

IN the fall of the year 1780, whilst I resided in the state of New-York, on the banks of a small river, named the Walkill, about seventy miles from the city of New-York, and fifteen miles in a perpendicular line on the west side of Hudson's river, a young man, whom I had employed to drain a deep and wet swamp on my farm, digged up the remains of a very surprising animal, without taking notice of any thing except the grinders. The bones were become so soft, that the spade cut them almost as easily as the clay. After breaking one of the grinders, he threw them on the side of the ditch; and being a stranger to contemplation, took no further notice of the matter, only on coming home at night, said among the servants, that he had found some strange stones in the ditch. I heard nothing of the affair at that time: but within a day or two after, went out to see

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the work, and discovered the grinders. I brought them home, ordered them to be washed; and, placing them in the order in which I fancied them to have stood in the animal's jaw, sat down astonished, musing over them for a considerable time. That same day I sent for a gentleman in the neighbourhood, a native of this country, and who had travelled much through it, to know whether ever he had seen any similar to them. He was as much astonished as myself. We went to the spot, and fell eagerly to digging. We found a large number of bones, but mutilated, rotten, and broken. It was impossible to handle many of them, without breaking them. We found the vertebræ or joints of the back, lying in a row, as they had been when the animal was alive: but the line, in which they lay, run out into the ditch, when all was marred; and in lifting them up they broke. We then discovered on one side of them, near to where they began, what we supposed to be the loin joint. We worked very carefully about it; and got it up; but it also fell in two pieces. On putting the pieces together, it measured twelve inches in diameter. A part of the tibia of this remained; from the cavity of which I extracted some thick viscid matter, resembling tar mixed with blood. We found another bone of a spherical form on one side. And though cut through by the spade, so as the cut encroached on the spherical part, its diameter measured six inches. It appeared to be the convex part of a joint; though more oblate than is common in other animals. The grinders were four in number. All belonged, it is probable, to one jaw; two to one side of the mouth, and two to the other.

The two innermost were exactly alike, and also the two outermost, or those which had been placed next the fore teeth. Each of the innermost measured three inches and a half in breadth, and four and a half inches in length. Each of the two outermost measured in length, rather more than seven inches, and in breadth, somewhat more than three and an half inches: but declined in breadth towards the fore-teeth. Two of these grinders had lost the cor, and nothing remained but the hard hollow ivory case. The other two retained each so much of the cor as was above the gums, in which were apertures for the insertion of the nerves; the largest of these apertures with difficulty admitted the point of my little finger. These grinders are exceedingly indented. One deep furrow runs the whole length of them; and, when placed two and two, as they must have stood in the jaw, there were four indentures, or furrows across that long line, which divided the surface of each pair into ten protuberances, rising in a pyramidical form, the perpendicular height of the highest of which was about an inch and one tenth. I should here remark, that each of the innermost grinders had four of these protuberances, and each of the outermost six: but some of them were considerably worn down by the animal's grinding its food; and it was easy to perceive, not only on the superficies, but also on the sides of some of them, evident marks of friction; the innermost chiefly bore these marks. The protuberances are rough, and of a dark grey colour; but when smoothed, by friction, appeared white and polished, as the finest ivory. What could this animal be? Certainly not a marine monster, for

it

it lay above a hundred miles from the sea: unless we can suppose, that not many centuries ago, that part of the country was covered by the sea. From the appearance of its monstrous grinders, it would seem as if it had been of the carnivorous kind. A gentleman who came to see the remains of it, told me, he had seen the skeleton of an elephant; but the biggest joint in it was much inferiour to what I have described as the loin joint; though it is probable, it had lost much of its magnitude. Doctor Michealis, physician general of the Hessian troops, who, with some other gentlemen, came to my house, after the peace, and before New-York was evacuated, in order to make further search (in which however, he was frustrated, by heavy rains having fallen) said he could not think it had been an elephant, as being in his opinion, much larger. He carried some of the bones to Germany with him. And others were sent to the museum in Philadelphia, kept by Mr. Semittien; and some were destroyed by careless country people, whilst I was abroad. Shall we, sir, suppose the species to be extinct over the face of the globe? If so, what could be the cause? It is next to incredible, that the remains of this animal could have lain there since the flood. May there not be some of the kind yet surviving, in some of the interiour parts of the continent? Comparatively little of it has yet been explored. Some gentlemen, with whom I have conversed, have supposed that their extinction (as it is probable they are extinct) is owing to some amazing convulsion, concussion, or catastrophe, endured by the globe. But I know of none that could produce such an effect, except the flood. Earth-

quakes

quakes might destroy some of them, but not all. And the remains of them have been discovered in different parts of the world. His Excellency, General Washington, came to my house to see these relicts. He told me, he had in his house a grinder which was found on the Ohio, much resembling these. And in the American Magazine of December 1746, there is an account of a tooth and bones, of what the author calls an elephant, discovered in England, which, I am persuaded, must have been of the same species. I shall conclude this narrative with the devout and rapturous exclamation of the Psalmist "Great and marvellous are thy works, Lord God Almighty!"

I am Sir, with much respect, your most
obedient, and humble servant,
ROBERT ANNAN.

To the PRESIDENT *of the* AMERICAN
ACADEMY *of* ARTS *and* SCIENCES.

XXIII. *A Description of a Horn or Bone, lately found in the River Chemung, or Tyoga, a western Branch of the Susquehanna, about twelve miles from Tyoga Point: Communicated by the Hon.* TIMOTHY EDWARDS, *of Stockbridge, Esq.; in a Letter to the Rev.* JOSEPH WILLARD, *D. D.*

January, 1788.

"IT is six feet nine inches long, twenty one inches round, at the large end, and fifteen inches, at the small end. In the large end is a cavity, two and an half inches in diameter,

eter, much like the hollow which is filled with the pith of the horn of the ox: This is only six inches deep. Every other part is, or appears to have been solid. The exteriour part, where entire or not perished, is smooth; and in one spot of a dark colour. The interiour parts are of a clear white, and have the resemblance of well burnt, unslacked lime stone; but these can be seen only where it is perished, tender, and broken. From one end to the other, it appears to have been nearly round; and on it there have been no prongs or branches. It is incurvated nearly into an arch of a large circle. By the present state of both the ends, much of it must have perished; probably two or three feet from each end. From a general view of it, there is reason to believe, that in its natural state, it was nearly a semicircle of ten or twelve feet. The undecayed parts, particularly the outside, send forth a stench, like a burning horn or bone. Of what animal this is the horn or bone, and what has become of this animal, are questions worthy of the curious and learned."

XXIV. *Observations on the Manufacture of Pot Ash. By* AARON DEXTER, M. D. F. A. A.

HAVING had frequent applications from the manufacturers of pot ash, to examine that article, when condemned by the assay masters, I have been led to several observations, which are generally the result of experiments, respecting its defects, and the causes of its impurity. From a conviction

a conviction that those defects may be easily remedied, I have committed my remarks to paper, with a concise history of the manufacturing of this salt, which I beg leave to submit to the consideration of the American Academy of Arts and Sciences. And if after their critical examination, they shall be thought to contain any useful hints, they will dispose of them as they think proper.

It is unnecessary to premise, that the great evil which injures the sale, and very much reduces the value of some of the American pot ash, arises from foreign matters, such as common salt and earth, being accidentally mixed with it.

The furnaces, and machines, or apparatus, commonly used in this country for extracting the salts from the ashes, and for boiling and fluxing them, are undoubtedly of a good kind.

The first important object to be observed, is to extract all the salts from the ashes. For this purpose, rain or river water ought always to be preferred. The ashes should be saturated, and remain with about an inch of water over the top of them twelve hours at least. Then a small opening may be made in the bottom of the leach tub, which ought to contain a strainer, in order to prevent the ashes from running off; or a false bottom may be used to advantage. The lie discharged is fit for immediate use. As soon as the manufacturer begins to draw it off, he must apply fresh water; and continue that application, and boiling the lies, until they are so reduced in strength, as that they will no longer pay the expense of boiling. The ashes are however,

still

still to be preserved ; and fresh water applied as before. And, when drawn off, they may be used with profit on fresh ashes, as long as there remain in the lies any salts, which may be discovered by the taste.

The lie that runs off for use, should be filtered as it passes the bottom of the tub ; and also as it runs into the receiver ; which process may be performed without any expense or inconvenience. Previous to boiling the lie, it ought to stand twenty four hours ; and then be drawn into the kettles with great care, so as to leave all the sediment behind. Every precaution should be taken to let nothing fall into the lies previous to, and whilst boiling. Therefore, that injurious practice of laying wood on the kettles for drying, must be avoided.

Strong lies may always be boiled half away in the first operation, and others much more : after which they must be taken with care out of the kettles, and put into a receiver at hand. Being so shifted, a very small quantity of unslacked lime may be put into it, which serves to clarify, and at the same time, renders the lie more pungent to the taste. Or, a quantity of lime may be mixed with the ashes, which will answer the last purpose.

After standing quiet until it cools to the state of blood heat, it must be again shifted ; and in drawing off the lie in every instance, the utmost care must be taken that all the sediment, which is generally a chalky earth, is detained ; which process will effectually separate all the common salt :

for

for that will congeal and crystalize with hot water in the same quantity as with cold water; which is not the case with any other neutral salt or alkali. If after all, from any circumstance unforeseen, the lies shall not appear pure and clean, after taken from the last sediment, they must stand quiet until another is formed; or until it appears, that no other will form. Should one form, it must be separated as before, prior to its being put into the kettles for the last operation. Without these precautions, the pot ash, in consequence of neutral salts, and a chalky matter which are obtained from the ashes, will be hard to flux; and require a long time to effect it; which will greatly endanger the kettles; and after it is fluxed, will be very impure; and sell for a reduced price, if the owner be fortunate enough to find a market at any rate.

The pot ashes which I have examined, that have been condemned by the assay masters, I have found to contain principally common earth; which is undoubtedly the chief source of impurity in the pot ash of this country. If any crystals of common salt or nitre appear in the sediment, they may be preserved and purified by an easy process, which is known to people in general, who have attended to the manufacturing of saltpetre.

After the lie is properly cleared from earthy matter, and common salt, which not only retards the fluxing process, as has been observed, but renders it unfit for many uses, particularly the bleaching of linens; it must continue boiling

until

until evaporation shall cease. Then the fire must be increased, until the salts are perfectly fluxed, for the purpose of destroying the inflammable substance, with which most of them abound; which may be determined by the following simple method. Take some pot ash and dissolve it in water. Let there be as much pot ash as the water will dissolve. Then plunge a piece of silver coin, or any thin plate of silver into the solution. If the pot ash contain any inflammable matter, it will change the silver to a dark or black colour, in the same manner as if it had been over the steam of burning sulphur. By this easy experiment, the manufacturer will be saved the expense and mortification of carrying pot ash to market, which must sell for a very reduced price. Should the workman discover, on the experiment being made, the inflammable principle, or what is called by the workmen, the oily substance, or fire, to exist in the pot ash, it can be remedied only by dissolving it in pure water, and boiling it down and fluxing it a second time. Or, it may be made into pearl ashes, by calcination, with little expense.

Some manufacturers may be discouraged from going through this process, by the labour necessary in shifting the lie so often. But if they consider the advantages they will obtain in fluxing their pot ash, which will be effected in less than half the time required in the usual way, and the great saving in the expense of kettles, by the lies being made clean and pure, they will be reconciled to the method, notwithstanding the trouble; as their interest will be found, on experiment, to be concerned in its adoption; and as their pot ash will find a more speedy market; and obtain a high-

er price. Besides, the manufacturer, and the merchant will never be doubtful of their adventures. And the reputation of American pot ash will be equal, if not superiour to any that is manufactured in Europe.

The subject of pot ash making has frequently been before the legislature, and applications made for premiums, by people, who have no doubt acquired useful knowledge in the business. This circumstance, and a wish to render service to the publick, are the only motives which have induced me to commit these observations to the Academy. I have endeavoured to avoid prolixity, and all chemical terms, as I wish to be understood by people concerned in this branch of business; all of whom may not have had the means of obtaining a perfect knowledge of them.

XXV. *Second Essai sur des Eaux de Boston. Par M.* FERON.

LORSQUE j'ai eu l'honneur de communiquer à l' Académie mon essai sur les eaux de Boston, j'ai dit n'avoir découvert aucune substance métallique. Depuis ce tems, on m'a communiqué, que certaines eaux de Boston avoient des qualités particulieres, telque de jaunir, noircir, et avoir mauvais gout, &c. Celles que je connois jusqu'à present, sont, celle de M. *William Greenleaf*, à coté de son magasin, dans

XXV. *Second Essay on the Boston Pump Waters. By* M. FERON.

WHEN I had the honour of communicating to the Academy my essay on the waters of Boston, I observed, that I had not discovered any metallick impregnation. Since that time, I have been informed, that some of the springs in that town had certain particular qualities, such as of staining yellow and black, and that they had an unpleasant taste. Those I refer to now, are Mr. Greenleaf's well, near his store, in the

dans la rue qui conduit de *Brattle Street* au Marché ; celle de M. *Joseph Hall's still house, by the Mill Pond,* et celle de *Mrs. Newman, Fore Street.* La saison ne m'ayant pas permis de les analyser toutes, je ne communiquerai à l' Académie que celle de M. *Greenleaf.*

Ce puits situé dans l'endroit mentionné ci-dessus, a de vingt à vingt cinq pieds de profondeur, sur environ trente de circonference. Sa source est si considerable, qu'elle peut fournir en douze heures une quantité d'eau suffisante pour le remplir.

L'eau présente des differences essentielles dans un espace de tems illimité. M. Greenleaf m'a communiqué, qu'ayant pompé de l'eau trés transparente, sans odeur, et sans presque de gout ; trois ou quatre heures après, voulant pomper de nouvelle eau, il la trouvoit opaque, ayant de l'odeur, et beaucoup de gout, enfin hors d'etat d'etre employé à aucun usage domestique : le même espace de tems apres, quelquefois

the street, leading from Brattle street, to the Market; that of Mr. Joseph Hall's distill house by the Mill Pond; and of Mrs. Newman in Fore street. The time not permitting me to analyze them all, I shall confine myself at present to the water of Mr. Greenleaf's spring.

This well, situated in the street above mentioned, is from twenty to twenty five feet deep, and about thirty in circumference. Its source is so considerable, that it will fill itself in twelve hours.

The water presents very different appearances at different times. Mr. Greenleaf has informed me, that having pumped out very fine transparent water, without smell, and almost without taste ; in three or four hours afterwards, he has drawn from the same pump, water that was opake, of a disagreeable smell, and strong taste ; in short, absolutely unfit for any domestick uses ; and then, in the same space of time, or perhaps a little

fois plus tard, elle redevenoit potable, et cela dans toute saison. On verra par l'analyse suivante la difference, que j'ai trouvée du soir au matin suivant.

En observant pendant longtems, on pourroit peut-être donner des raisons satisfaisantes d'un changement si subit. Un puit situé un peu au dessous, et que M. Greenleaf m'a dit être fourni d'eau par le sien, pourroit peut-être aider à rendre raison de ce fait. Mes hypotheses ne me satisfaisant pas à ce sujet, pour les communiquer à l' Académie, je me contenterai dans ce moment à donner l' analyse de l'eau : J'observerai que cette analyse ne pourra se dire complete, que quand on l'aura répétée un nombre de fois, à differens tems vu l'inegalité de ses resultats.

Voici ce que m'a fourni la premiere analyse.

L'eau avoit une apparence un peu opaque, une odeur désagréable, un gout nauseabond, astringent. En la versant de haut, elle petilloit. Son poids est de cinquante grains

par

a little longer afterwards, it would be good and wholesome again: and these changes were observable in every season. It will be seen by the following examination, what difference was observed from night, to the next morning.

Perhaps after long observation, we might be able to give satisfactory reasons for so sudden a change. There is a well a little below, which Mr. Greenleaf says is supplied with water from his: this circumstance might perhaps assist us to an explication of the facts. My hypothesis however, is not so satisfactory, as to induce me to submit it to the Academy, and I shall content myself at present, with the following analysis of the water; observing that this analysis cannot be called complete, till the experiments have been often repeated, and till we have at different times observed the inequality of the several results.

The first examination was as follows:

The water appeared a little opake, having a bad smell, and a nauseous, astringent taste. Poured from on high it sparkled. It is fifty grains in a pint * lighter than distilled wa-

ter

* An English Quart.

par pinte (A) plus légère que l'eau distillée. Sa temperature est de 42 deg. le thermometre etant à l'air libre à 46. Elle ne dissout point le savon. Examinée sur le champ, elle donne, une tincture rouge, foncée, tirante sur le noir, avec la rhubarbe; une cramoisie, tirante aussi sur le noir, avec la cochenille; une bleue tres foncée, avec le bois de Campêche; et une pourpre foncée, avec la poudre de noix de galle: l'esprit volatil fournit un précipité en petils flocons grisatre; et la lessive pour le bleu de Prusse, des flocons jaune ou ochre.

Par l'addition de quelques gouttes d'huile de vitriol, elle devenoit parfaitement transparente; il ne paroissoit point d'ebullition. Cette eau devenoit laiteuse par l'addition de quelques gouttes de dissolution d'argent, ou de mercure, par l'acide nitreuse; elle deposoit un sediment de meme couleur.

Un gallon, mis en evaporation, a fourni cinquante-huit grains de résidu, couleur grisatre meleé de jaune. Aussitôt que l'eau commence à chauffer, il s'en dégage beaucoup

d'air;

(A) Quart of Boston.

ter. Its temperature is 42 degrees, when the thermometer stands at 46° in the air. It will not dissolve soap. Examined on the spot, it strikes a deep red inclining to black, with rhubarb; a crimson inclining also to black, with cochineal; a dark blue, with logwood; and a deep purple, with nutgalls: volatile spirits produce a greyish precipitate, in small flocculi; and the phlogisticated alkali throws down a yellow sediment or ochre.

By adding some drops of oil of vitriol, this water becomes perfectly transparent, without suffering any ebullition. A solution of silver, or of mercury, in the nitrous acid, makes it milky; and lets fall a sediment of the same colour.

A gallon leaves on evaporation, fifty eight grains of a greyish residuum mixed with yellow. As soon as the water begins to boil, it eliminates a great deal of air, and forms

a thin

d'air; et il se forme à la surface une pellicule mince, couleur de perle. Pendant l'evaporation, une terre jaune et trés légère, tirante un peu sur le brun, s'attache au bord du vase superieurement; on peut la recueillir; elle est de dix grains par gallon: elle ne paroit être qu'une ochre trés déliée, melée d'un peu de terre calcaire.

Si on fait bouillir cette eau promptement, cette terre, ou ochre, se dépose au fond du vase. L'éau a perdu alors beaucoup de ses qualités martiales, comme on le verra ci-aprés.

Si on dissout ce résidu dans l'eau distilleé, il reste sur le philtre une terre grise mêlée avec l'ochre, et qui en etant séparée, n'est autre chose que celle dont j'ai parlé dans mon essai. Le sel que l'on obtient, est d'environ vingt-quatre grains par gallon. Il est le même que celui des pompes en général: les seules differences sont, qu'il est moins coloré, et ne laisse point de mauvais gout sur la langue.

Si

a thin pearl coloured pellicle on the surface. During the evaporation, a very light yellow, brownish earth adheres to the sides of the vessel above, to the amount of ten grains to a gallon: it appears to be only a fine ochre mixed with a little calcareous earth.

If the water is made to boil violently, this earth, or ochre, subsides to the bottom of the vessel. The water seems then to have lost much of its martial impregnation, as will be seen hereafter.

If this residuum be dissolved in distilled water, there remains on the filtre a grey earth mixt with ochre, which being separated, is no other than what I have mentioned in my essay. The salt obtained amounts to twenty four grains in a gallon; and is the same with what is commonly found in pump waters: the only differences are, that it is not so high coloured, and leaves no bad taste.

If

Si on expose cette eau pendant quelque tems á l'air libre, elle perd une quantité assez considerable de bulles d'air : elle ne devient point transparente, mais perd sa mauvaise odeur, son gout nauseabond, et un peu de son astriction : elle depose une ochre dissoluble dans les acides, environ trois grains par pinte, et se couvre d'une pellicule couleur de perle : elle ne dissout point le savon : donne une tincture jaune, tirante sur le rouge, avec la rhubarbe ; une cramoisie, avec la cochenille ; une rouge, tirante sur le cramoisie, avec la cochenille ; une rouge, tirante sur le cramoisie, avec le bois de Campêche ; et avec la noix de galle, une couleur peu differente de celle que l'on obtient d'avec l'eau pure : l'alkali volatil donnoit un precipité blanc ; la lessive pour le bleu de Prusse donnoit à l'eau une légère couleur verte.

Si on fait bouillir cette eau pendant un instant, elle présente les mêmes phénomènes que dessus, c'est à dire, qu'après avoir été exposée à l'air libre environ vingt quatre heures.

L'EAU

If the water be exposed to the open air for a little time, it discharges a considerable quantity of air bubbles : it does not become transparent, but loses its bad smell, its nauseous taste, and a little of its astringency : it deposits an ochre, about three grains to a pint, soluble in acids, and is covered with a pearl coloured pellicle : it will not dissolve soap : gives a yellow, reddish die, with rhubarb ; a crimson, with cochineal ; a red, inclining to crimson, with logwood ; and with nutgalls, a tinge very little different from that of galls in pure water : volatile alkali produces a white precipitate ; and the phlogisticated alkali for making Prussian blue gives a light green colour.

If this water be made to boil for an instant, it presents the same appearances as above, that is, after having stood twenty four hours in the open air.

THE

Seconde Analyse.

L'EAU etoit transparente, sans odeur, et ne petillante point, un gout astringent légèr; vingt grains par pinte plus pesante que l'eau distillée; sa temperature 42 deg. le thermometre à l'air libre à 44: fournit une tincture jaune foncée, avec la rhubarbe; une cramoisie, avec le cochinille, et la precipitoit; un bleue légère, avec le bois de Campêche; une brune rougeatre légère, avec la poudre de noix de galle; un precipité blanc, avec l'alkali volatil fluor; peu de couleur et de precipité, avec la lessive pour le bleu de Prusse. Exposée à l'air, ne perd point, ou que très peu, de bulles d'air; perd de son astriction; devient tant soit peu opaque: ne dépose point d'ochre, mais un peu de sediment blanc.

La dissolution de savon par l'eau de vie, de l'argent et du mercure par l'acide nitreuse, les tinctures avec la rhubarbe, la cochenille, le bois de Campêche, et la noix de galle, l'alkali volatil fluor, et la lessive alkaline pour le bleu de Prusse, ont donné les mêmes resultats qu'avoit donné l'eau de la premiere analyse, après avoir sejournée à l'air libre.

Si

Second Analysis.

THE water was transparent, without smell, not sparkling, having a light astringency; its specifick gravity twenty grains in a pint greater than that of distilled water; its temperature 42° when the mercury stood at 44° in the air. It produced a deep yellow, with rhubarb; a crimson, with cochineal, which was precipitated; a light blue, with logwood; a faint reddish brown, with galls in powder; a white precipitate, with the fluor alkali; and but little change of colour or precipitation, with the phlogisticated alkali. Exposed to the air, it discharged little or no air; lost its astringency; became in a small degree opake; let fall no ochre, but a small quantity of white sediment.

A solution of soap in brandy, silver or mercury dissolved in the nitrous acid, the tinctures of rhubarb, of cochineal, logwood, and nutgalls, the volatile alkali fluor, and the lixivium of the phlogisticated alkali, gave the same results as were observed in the first experiments on the water, after having exposed it a while to the air.

Being

Si on la fait bouillir, elle ne change presque point, excepté qu'elle dépose une petite quantité d'ochre dissoluble par le acides.

L'evaporation a fourni le même résidu que dans l'analyse précédente, a l'exception d'environ dix grains par gallon de moins: la plus grande partie de ces dix grains, ochre.

D'après ces analyse, que peut on conclure? D'abord, qu'en outre de la terre et du sel dont j'ai fait mention, une quantité de fer est dissoute par l'air fixe, ou gas mephytique: qu'elle fournit à peu près les mêmes résultats que les eaux de *Spaw* et *Pyrmont,* à l'exception de leur gout aigrelet. Pour m'en assurer plus positivement, je composai de l'eau artificielle de *Pyrmont:* elle m'a donné les mêmes resultats, sur tout quand je me suis servi d'eau de pompe en place d'eau distillée pour la composer.

Cette eau doit participer beaucoup des vertus des eaux de *Spaw* et *Pyrmont,* employées en Europe dans plusieurs maladies

Being made to boil, it shewed scarcely any change, except that it let fall a little ochre, soluble in acids.

Being evaporated, it left the same residuum as in the preceding analysis, except that it was about ten grains to a gallon less in quantity; the greatest part of which ten grains was ochre.

From these experiments what are we to conclude? It would appear first, that beside the earth, and salt mentioned, a quantity of iron is dissolved by means of fixt air, or the mephitick gas: and that it exhibits the same phenomena with the waters of Spa and Pyrmont, excepting the acidulous taste. To make the matter more certain, I made some artificial Pyrmont water; which on trial, gave the same appearances, especially when I used common pump water instead of distilled water. This water must of course partake largely of the virtues of Pyrmont, and Spa waters, which are successfully employ-

 ed

maladies, avec beaucoup de succés. C'est aux medecins à en constater les bons effets par l'usage, et en observant les differens etats ou degré de l'eau quand ils l'employeront.

Il se présente une difficulté dans l'usage ; c'est son changement subit : cependant dans cet etat plus foible elle présente les mêmes vertus, mais à un degré peut-être inferieur. Il seroit possible, dans le tems où elle est forte, de la conserver en bouteille, comme on fait celles de *Spaw* et *Pyrmont*, en y donnant les mêmes attentions.

Si mes occupations et le tems que je passerai ici avant d'aller en Europe, me permettent d'analyser l'eau des autres puits dont j'ai parlé, elles donneront peut-être les mêmes resultats sans avoir le même inconvenient.

ed in Europe, in many diseases. It is the province of the physician, to demonstrate their good effects by trial, and by observing the different states, and degrees, in which they may be drank. If directing the use of this water is attended with any difficulty, it must arise from the sudden changes to which it is liable; but in the state of its weakest impregnation, it seems to possess the same qualities, though perhaps in an inferiour degree. In its highest impregnation, it might be preserved in bottles as the waters of Spa and Pyrmont are, if the same attention was employed.

If my engagements, and the time I have to spend before I embark for Europe, should permit me to examine the other springs mentioned, perhaps they might afford us the same agreeable qualities, without the concomitant inconveniences.

XXVI. *On the Theory of Vegetation.* *By* NOAH WEBSTER, JUN. ESQ.

Hartford, June 12th, 1790.

SIR,

THE theory of vegetation is a subject in itself curious and amusing to a philosophic mind, and has always been

been considered in this light by rational enquirers after truth. But I question whether the true principles of vegetation may not furnish more useful and important lessons to our farmers than even philosophers generally imagine.

It is a well known fact that many vegetables, as clover, peas, beans, and vetches, help to fertilize exhausted feelds, especially if *plowed in,* as the farmers call it. But I cannot find that the true reason of this effect is generally understood. I wish if possible to diffuse a knowledge of the cause, in full confidence that the principle may be applied to many beneficial purposes in agriculture.

Vegetables, when analized, are found to consist of water, earth, oil and salts. It seems to be the generally received opinion among philosophers, that the cementing principle, by which the component parts of vegetables are held together, is fixed air. With these substances there is united a portion of phlogiston; but the parts which contribute most to fertility are oil and salts. Now it is agreed among the lerned, that vegetables are furnished with inhaling or absorbing pores, and that the pores of the leaves and branches serve the double purpose of alternately inhaling and exhaling, according to the temperature of the atmosphere. All this is admitted by modern philosophers, yet they contend that vegetables derive their principal nurrishment from the earth. It appears to me this cannot be true in the extent it is commonly supposed; for if true, I do not see how vegetables of any kind should enrich the land on which they grow, so rapidly as some of them do.

A crop

A crop of clover will fertilize an exhausted feeld, altho the clover is mowed, and the body of it carried from the feeld. But if the clover draws the principal part of its oil and salts from the earth, and the most of the growth is cut and carried off from the feeld, one would think that insted of enriching, it would impoverish the soil.

The constituent parts of vegetables are contained in the atmosphere; and it is rational to suppose that different vegetables imbibe more or less nurrishment from the air, according to their different organization. Those plants which are of a firm texture probably imbibe most of their nurrishment from the earth; as flax and hemp, which require very rich land and impoverish the soil where they grow. But plants which are of a more spongy texture, and whose leaves have larger pores, probably imbibe most of their food from the atmosphere; as clover, vetches, peas and many other succulent plants. This I take to be the reason why the latter enrich the soil where they grow; especially when suffered to rot upon the soil. They imbibe the oily and saline substances from the air, and their vessels serve as tubes to convey them to the earth.

It may be said, that the particles inhaled by the leaves, during one part of the day, are thrown off by perspiration, during another part. But it is only the most volatile and fluid part of the nurrishment which is thrown off in this manner, that is, the water. The exhalations of plants are mostly during the heet of the day; the process of absorption is principally during the night, and then is the time

when

when vegetables grow most rapidly. This is a fact within every man's observation. The more solid parts of vegetables therefore, when imbibed, immediately cohere and attach themselves to the plant, and the watery particles only or principally are liable to be exhaled by common summer heet. It appears probable that the nurrishment of the more succulent plants, being mostly imbibed from the air, conveys more of the enriching substances to the roots, than is derived from the roots to the branches. And this may be the reason why a growth of clover will fertilize land, even when the body of the crop is carried off.

But whether this is true or not, it is a fact that vegetables do imbibe nutriment from the atmosphere, and this is undoubtedly the reason, why all vegetation will fertilize land, provided the whole growth is permitted to ferment and putrify upon the land. It is owing to this circumstance merely that land newly cleered is rich and fertile. The trees have for ages been inhaling the oil and salts of the atmosphere; the leaves and some of the limbs have been annually falling upon the earth, where they putrify and form a rich black mold, abounding with oil and salts, which were collected from the air. And I am surprized that our farmers, who are constant observers of these facts, have not attended more to the principles which produce them; for I do not see how men, who are constant eye-witnesses of the effect of putrified vegetables in fertilizing land, can suffer their old feelds to lie barren for a number of yeers in order to become rich. The seed of clover, beans, peas,

buck

buck wheat, rye, turnips, oats and almost any other plant the seed of which can be collected, would be purchaseable at a small expense, and a crop or two turned into the most exhausted soil; would render it fertile. Suppose a man should sow three bushels of oats upon an acre, (and on poor land a large quantity of seed would be necessary) the expense would be 4*s*. and 6*d*. Add to this, a day's plowing in preparing the ground, and another, in plowing in the crop, when nearly full grown. The expense and labor are not considerable, and such a quantity of fresh vegetation, covered with earth, and there fermenting, would be equal to twenty, thirty or perhaps fifty loads of stable manure. The necessity of attending to these principles is increesing every day in this part of America, where a great part of the land is impoverished by long cultivation. To suffer old feelds to lie without any vegetation upon them, except a spontaneous growth of weeds, is an immense loss to the farmer. The air contains the principles of fertility, but a barren earth will attract and absorb these principles very slowly, without the help of vegetation. The plowing of land has a good effect, especially just before winter, as by loosening the surface, it prepares the soil for receiving and retaining the salts with which the atmosphere is impregnated. But the most efficacious method of collecting the fertilizing particles of the air, is, to seed the earth with some of the succulent plants, which feed upon these particles.

It should be observed further that when the plants have obtained their growth, they should be plowed in; for being covered, they produce fermentation, and the oil and salts are

all

all blended with the earth; whereas when suffered to putrify upon the surface of the ground, they dry up, and their fertilizing substances are again mixed with the atmosphere. This remark, if true, exposes the absurdity of the practice of feeding cattle during winter, in the open feeld. In Rhode-Island the farmers have few barns; the hay being stacked and their cattle fed upon the mowing feelds. But the manure they leave upon the land is much less than the same cattle would make in a stable, or at least is less useful, from the manner in which it is cast upon the land. Besides vast quantities of hay are wasted, and being thrown upon the ground in a scattered manner, it produces no fermentation and little benefit to the soil. In addition to this, cattle exposed to the severe cold of winter, eat more hay, and do not grow to the same size, as cattle kept in a warm stable.

I have one remark more to make, which derives its force and propriety from the doctrine, that vegetables receive much of their nutriment from the atmosphere. It is, that in severe drouths the leaves of garden plants should be watered as well as the roots. We often heer gardeners say, that certain plants will die in a drouth, altho watered every day. Indeed it cannot be otherwise, when the largest part of the plant is almost destitute of nurrishment. The roots of many plants will bear to be robbed of nurrishment much better than the leaves; thus a cucumber will live longer by watering the leaves than the roots. Copious dews will partially supply this pabulum for the leaves, and this perhaps is the meening of that passage of scripture which says, "a

mist

mist went up and watered the face of the earth;" as the case is still in some eastern countries.

I will close this letter, Sir, by relating an experiment I have lately made to ascertain the evaporation or perspiration of plants, growing in a damp cellar, unconnected with earth.

On the 9th of May I weighed two potatoes, on which the young shoots just began to appear. I placed them both in a dark corner of the cellar, on a dry piece of timber. I weighed them both on the 28th of the same munth, and on the 11th of June. The result of the whole follows:

The largest weighed.

	oz.	pwt.	grs.		pwt.	grs.
May 9th,	1	18	19			
May 28	0	13	0	— loss of weight in 19 days	5	19
June 11	1	12	11	— loss of do. in 14 days	0	13

The smallest weighed.

	oz.	pwt.	grs.		grs.
May 9th,	1	0	8		
May 28	0	19	19	— loss of weight in 19 days	13
June 11	0	19	4	— loss of do. in 14 days	15

The shoots in the meen time had grown to the length of two and three inches. Those of the largest, when broken off, weighed 1 penny weight 7 grains; those of the smallest, 18 grains; so the actual diminution of the potatoes in 33 days, was 6 penny weight 8 grains of the largest, and 28 grains of the smallest.

The perspiration of plants is ascribed to the expansion of the air in the tracheæ, in consequence of being heeted. The

absorption

absorption of moisture is owing to the contraction of the air in the same vessels, which occasions the exterior vessels to dilate. Now a potatoe kept in a cool cellar of uniform temperature cannot perspire very freely; and probably the similar roots, placed in water and exposed to changes of heet and cold in the open air would have thrown off by perspiration, twenty times the quantity of water, which those did in the cellar. At the same time, a vegetable confined to a dark room will flourish but indifferently, as it is deprived of an essential part of its food, phlogiston.

Whether this communication contains any thing new or sufficiently interesting to deserve the notice of the American Academy of Arts and Sciences, is left wholly for you to determin. All I know for certainty is that it proceeds from a sincere desire to serve the agricultural interest of my country, and that I am, Sir, with great respect,

your obedient and

very humble servant

NOAH WEBSTER, Jun.

Rev. Dr. Willard.

MEDICAL PAPERS.

I. *An Account of an Uncommon Case of Emphysema; and of an external Abscess whose Contents were discharged by coughing.* *By* EDWARD AUGUSTUS HOLYOKE, M. D. F. A. A.

ON Tuesday, July 15th, 1783, I was desired by the gentleman who attended him, to visit a boy of about twelve months old, who he told me had been most severely handled by a peripneumony for ten days; but that a very uncommon tumour lately appearing upon the child, made him desirous I should see him.

Upon viewing the patient, I found a large soft elastick flatulent tumour, evidently crackling under the fingers when pressed upon, as tumours arising from air in the cellular membrane, usually do. This tumour shewed itself all at once on the preceding evening, about seven or eight o'clock, as the child lay in its mother's lap, during a violent fit of coughing, on one side of the neck, near the right *mastoid muscle*; and by ten o'clock, the next morning, when I first saw it, it had spread across the neck, and up by the left ear, under the scalp, so as to cover the whole extent of the *crotaphite muscle* on that side; on the left side, it extended no further up than the ear; downwards, it spread on the breast below the paps on both sides, and to each *axilla*, and was evidently increasing, especially upon coughing.

The

The pulse was frequent, the flesh hot, the respiration, deep, frequent, and laborious to a great degree; the cough frequent and violent, and the mouth lined with *apthæ*; but none of these symptoms were increased (as I was informed) since the *Emphysema* had taken place: The child appeared in the utmost danger.

About one o'clock the same day, I saw the child again; the symptoms continued much the same; but the *flatus* had spread on the left side of the head up to the *vertex*; and farther down upon the breast; and farther round than the *axillæ*.

The next morning, Wednesday the 16th, the *Emphysema* occupied a larger space upon the head, though chiefly on the left side still; had extended over both *scapulæ*; and had got further down on the breast, and indeed covered the whole *thorax* on the forepart, and on the left side passed over the oblique abdominal muscles down to the groin. The child had now a more cadaverous look; the hands were purplish, and the pulse plainly lower and more sunk; the difficulty of breathing still kept up; and we expected he would soon expire.

Thursday 17th, A. M. Matters in much the same situation as yesterday, only the tumour now extended over both sides of the abdomen, but did not pass over the *recti* muscles, covered almost all the back, and on the head, had passed over the *vertex*, and now covered the whole right side.

Friday 18th, the child still alive; the *dyspnœa*, cough, &c. still continued. He had taken no medicine, for twenty four

hours

hours past, nor had swallowed any thing but a little drink. The tumour now covered the whole trunk, except a small area round the navel, and a narrow stripe both above and below it, upon the *linea alba*, which were free from all swelling; the whole neck was puffed up, and the head under the hairy scalp every where, except the back part; where the air seems to have been prevented from insinuating itself, by the pressure of the head, as it lay upon the pillow; the face was every where free, as also both the upper and lower limbs. This evening the child died; but to our great mortification, no persuasions could prevail upon the mother, to permit the body to be inspected. The appearance of the tumour upon the dead body, was much the same the next morning, as it had been before death.

To account for those uncommon appearances, I think we must suppose a communication some where, between the cavity of the lungs, and the cellular membrane; and as the first appearance of *Emphysema* took place in the neck, upon a violent fit of coughing; it seems highly probable that this communication was formed, by a rupture of the membranes of the *aspera arteria*, somewhere between its cartilages;* and thus gave passage to the air from the lungs into the adjacent cellular membrane, at every expiration; and as the cough was very violent, the air would at every such effort more especially, be forcibly impelled through this opening, and thus extend itself wherever this membrane extended;

* Possibly a small abscess might be formed between these membranes, and so by weakening them, occasion their bursting, upon a violent exertion in coughing.

tended; at first indeed more rapidly, but still continue to extend, till the resistance which the air met with, in passing out at the opening, was equal to the force by which it was expelled from the *trachea* in expiration or in coughing.

This solution of these appearances cannot be ascertained, as we were not allowed to open the body, and whether it will be thought admissible I cannot determine; but as another case which fell in my way not a great while ago, may throw some light upon this, I will take the liberty to relate it.

A man about fifty three or fifty four years old, of a thin habit of body, labouring under a very bad cough, attended with a hectick fever, profuse sweats, &c. had a large tumour formed upon the upper part of the thorax on the left side, extending from the shoulder, all along the lower edge of the clavicle, to the *sternum*, about the breadth of a man's hand. This tumour had all the appearance of a large abscess; it was accordingly treated as such, and suppuration seemed to be coming on as usual; but on removing the dressings one day, I found the tumour (though the skin remained whole) less prominent to the eye, flabby to the touch, and the pain and inflammation abated. I was now at a loss what to make of the case, as the abscess seemed too far advanced to expect discussion. While I was thinking of the matter, the patient asked me, "what could occasion that blubbering noise (as he expressed himself) in the sore?" Upon which, applying my ear near the part where he perceived the noise, I plainly heard a whizzing, and

as

as he termed it, a blubbering noise at every breath, exactly resembling such as arises from the rushing of air through a small orifice. This orifice appeared to be just under the left *clavicle*, but nearer to the shoulder than the *sternum*. Upon viewing the part attentively, a small dilation and contraction was perceptible upon expiration and inspiration; and the part was evidently puffy and flatulent to the touch. At this time the cough was urgent, and the expectoration very copious.

From this time, the tumour, inflammation, and hardness, subsided; the noise in breathing gradually lessened, till it ceased; and by the assistance of pectoral medicines, the bark, &c. the hectick and cough after a while left him; and with them the sweats, &c. his appetite returned, and he recovered his strength, though slowly; and is at this time in tolerable health.

In this case I think it certain that the inflammation penetrated to the lungs, which no doubt adhered to the *pleura* in this part; and the abscess bursting inwardly, the matter was discharged through the *trachea* by the assistance of the cough, which was at this time very constant; but the cavity of the lungs having now a communication with the cavity of the abscess, some of the air from the lungs would pass at every expiration into this cavity; but would not diffuse itself in the cellular membrane and produce general emphysema in this case, as in the case first mentioned, probably because, the inflammation of the cellular membrane, which surrounds all abscesses, and limits their extent, must have

formed

formed a barrier impenetrable by the air, as it rushed out of the lungs into this cavity; and of course the whole of what was thrown into the cavity of the abscess at each expiration, would be drawn back again into the lungs, at the next inspiration, and thus the surrounding parts might escape tumefaction: and this passing and repassing of the air will fully account for the noise, which the patient complained of.

II. *Account of a Locked Jaw. By* AARON DEXTER, M. D. F. A. A.

Boston, January 26th, 1790.

SIR,

I BEG leave to present to the Academy, a particular history of the unfortunate case of my friend, Dr. Edward Wyer. It rarely happens, that the particular circumstances attending the disease, with the full effect of applications, and a constant variation of practice, as symptoms appeared, can be attended to as was the case in this instance: owing to his having no other nurses than such physicians, with his own assistance, as were able to change the mode according to appearances.

I presume, it may give some information to medical gentlemen, who have not had an opportunity of being witnesses to such distressing scenes.

I am, with the greatest respect,

your most obedient servant,

A. DEXTER,

The Hon. JAMES BOWDOIN *Esq.*
President of the A. A S.

An Accurate History of a Locked Jaw, from a wounded Membrane, that terminated fatally.

August 25th, 1789.

EDWARD WYER, a gentleman of the medical profession, trod upon a shingle nail, which passed through his shoe, into the ball of his left foot, directly over the tendon leading to the second toe. A few drops of blood followed. He applied only a little petrolium to the part.

The next day, a slight lameness ensued, with nausea at the stomach. The third day, it was apparently well; and he attended his usual business without any regard to his foot.

Sunday, September 7th, whilst at dinner, he observed some difficulty in swallowing. Monday 8th, he perceived a considerable stiffness in the muscles of his neck. On Tuesday the 9th, it increased, but not so much as to prevent his riding ten miles in the afternoon: and he concluded, he was attacked with the mumps. He applied, in the evening, vol. linament to his neck and jaws. During the night, he was restless; and after sleeping, repeatedly found, that he had bit his tongue.

Wednesday morning the 10th, he perceived a stiffness in his back, as though he had been sleeping on a board; and could scarcely open his mouth. Upon his attempting to speak, or swallow, spasms seized his throat. At this time, he was fully convinced, that he had a locked jaw: and the affair of the nail was recollected, with all its circumstances.

During the forenoon, his disorder increased rapidly. At 12 o'clock, a medical friend called on him by accident, he made an effort to speak, but could not for some minutes.

As

As soon as he was able, he related his case, and asked advice. They conversed on the several different remedies that have been recommended. Opium he conceived of no avail: he said, that he had made patients under his care, eat it by the pound. The warm bath was mentioned; but he objected. He agreed, that a cold bath was the only thing that could save him. Mercurial frictions were mentioned; but he would not consent; and answered, that he had often tried them without any sort of advantage. He then recited the cases in the 6th vol. of the London Medical Observations, proving the good effects of cold water; and, at the same time, produced his own minutes of a case of a locked jaw, cured apparently by cold bathing; which took place about twelve months before in a neighbouring town.

On examining his foot, nothing was perceived but a very slight speck where the nail entered. There was no soreness, tenderness, or pain in that part, more than in any other. It was agreed to apply the cold bath immediately. He placed himself on a low stool, naked; and two buckets of cold water were thrown on his head: after which, he placed himself between two blankets on his bed. An agreeable warmth soon took place; and he expressed relief, from the application, particularly at his stomach; and could swallow better.

The first application was about 1 o'clock, in the afternoon; and repeated exactly in the same manner, four times.

At 6 o'clock, he was evidently relieved. After the fourth bath, he rose from the stool, with great satisfaction; could speak with ease; and drink without difficulty. During the five hours, he took liberally of broth and gruel. The fifth

bath had a very different effect: it produced a tremor, and great anxiety. Spasms attacked him more violently than ever, particularly on the back of his neck; which was embrocated with oil of cloves, diluted with spirits of wine. The spasms were very violent also in the muscles of his jaws. To prevent his mouth closing completely, which he apprehended, he had introduced a stick between his teeth; and this was of great importance to him, during his life. At this time his foot was examined; and the speck taken out; which did not shew any trace of the nail under the scarf skin. A blister, as strong as could be made, was applied to the part: but he was utterly averse to having the tendon examined; conceiving it too late to make any application to the part originally affected, as the disease had become general.

He wished to have the system supported with wine, bark, and nourishment.

The bath of cold water was tried again, at 8 o'clock; but it evidently increased his disorder; and from that time, he would never consent to its application.

During the night, several enemas were administered, of a strong decoction of red bark, and snake root. At his usual bed time, an anodyne of two grains of opium was given him: he passed a very restless night. He soon found, that cold drinks produced less spasm than warm; which led him to take every thing that he was able to swallow, cold.

Thursday 11th, it was proposed to him, to pass a seton, covered with cantharides, under the skin of the affected part. To this he consented, with a design to inflame the part: but it produced no good effects; it seemed rather to increase his irritability. In the course of the day, three enemas were administered of a decoction of bark, as before.

He

He had a great aversion to bark in any form, received into his stomach; as it generally, in health, produced nausea. The object of this application was to give tone to the stomach, presuming that debility was the immediate effect of the disease.

The gentlemen of the medical profession, who were present, suggested to him the use of the warm bath; as every other application had proved of little effect: to this he consented. About 4 o'clock, in the afternoon, he was placed in a bathing machine, with water heated to 90° of Fahrenheit's thermometer, in which he remained seventeen minutes. It produced a good effect, in relaxing the muscles in general, particularly of his body and arms. Growing faint, he was taken out; covered with flannel; and put on his bed. A most profuse diaphoresis ensued; and he felt so much relieved, that he said, he then had a secret hope that he should recover: but, within an hour, on attempting to drink some lemonade, his spasms returned as violently as before, and more general; but seemed to remit at shorter periods.

At 8 o'clock, he was anxious to try the warm bath again; and was placed in it as soon as possible, but without any good effect. He could bear it but a few minutes, before he became faint; and spasms attacked him in this situation. He passed a better night than he expected; and obtained some sleep, by keeping his head accurately balanced.

Friday 12th. This morning he seemed better; his spasms were not so violent; and he was much encouraged. A laxative enema was administered; as nothing had passed his bowels since Wednesday morning. In the afternoon, spasms returned more violent than ever, and more general. The

warm

warm bath was again used, but without procuring any relief: and he passed a very distressing night.

Saturday 12th, a cathartick of calomel was proposed, which met his approbation. It is to be observed that he now preserved his reason entirely; and was unfortunately able to judge for himself of his situation, and the full effect of every application. He had, from the first moment, considered his case out of the reach of medical assistance.

This morning, electricity was proposed, which he approved. And such sparks were drawn as he was able to bear, without producing spasms, from the parts most affected. The electrick fluid was passed through him in various directions, for about one hour. He thought himself calmer in consequence of the application; and passed the day without violent spasms. Electricity was repeated in the evening, but without any apparent effect. His sensibility had much increased since Thursday night. Constant attention was necessary from the physician, to keep the muscles exactly balanced.

In the evening, it was agreed to make use of mercurial frictions; as there had been some similar cases related, in which this application had succeeded. It was used through the night very freely. A laxative enema was also administered without effect. His thirst was very great. From 9 o'clock in the evening, to 6 o'clock the next morning, he drank five pints of cold water, and as much lemonade.

Sunday 13th. A discharge from his bowels was produced; but was not considered as sufficient. And ten grains of calomel were given him, with one hundred drops of laudanum. He passed a tolerable day without any violent spasms; took but little food, as his stomach nauseated it; but drank cold water and lemonade in large quantities. At 4 o'clock

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in the afternoon, an enema was administered of broth and half an ounce of laudanum. It was agreed to omit the mercurial frictions; and keep him as quiet as possible; and to give him as much food as could be retained on his stomach, or by his bowels. The laudanum soon had an effect. At 5 o'clock, he lay quietly sleeping under its influence. Appearances were favourable at this time, in the opinion of all the medical gentlemen present. He continued quiet, and slept easy till ten o'clock; when a laborious respiration took place. An attempt to awake him was made without effect; and the difficulty seemed to increase very fast. He was then raised up in his bed; and carried to a chair, without any signs of life, except an interrupted catching for breath, and a very feeble pulse. The most stimulating volatiles were applied to his mouth, nose, temples, &c. without any effect. At 11 o'clock, his respiration was scarcely perceptible; and his pulse intermitted. He was laid on his bed as a dead man. In a few minutes, his pulse seemed more connected. He was raised up on the side of the bed; and all the windows were opened; and an enema was administered of a solution of cathartick salts in strong peppermint water; which, in a few minutes, operated very largely; and part of the laudanum was evacuated. His respiration gradually recovered; and his pulse rose full. These circumstances induced his medical attendants to repeat the enema as before; at half past 12 o'clock, he was again placed in his bed, and breathed tolerably easy; and had a copious involuntary discharge. The external stimulating applications were continued; and his spasms returned in a slight degree, just sufficient to lock his jaws during their continuance. Every muscle had been perfectly relaxed

since

since 10 o'clock. His respiration grew gradually better; and at 3 o'clock, he was able to speak; and found to his great surprise, the muscles of his jaws relaxed, and as free from spasm as he ever was. His thirst was violent: he drank from 3 o'clock to half past 5, one quart of cold water, two quarts of lemonade, and a bottle of spruce beer. After this he slept quietly half an hour. There seemed to be a singular alteration, and he was very much elated; and fully believed, that a complete crisis had taken place. He continued free from any spasm, particularly in his jaws and neck, till seven o'clock in the morning.

Monday 14th. At 8 o'clock his left leg and thigh were extremely affected with spasms. The violence and pain of them were so great, that during three hours, he was, for the first time, deprived of his reason. At the intervals he begged for an enema of laudanum, as the only thing that could save him from the severest torture. Electricity was first tried on the part, but without any effect. Afterwards, an enema was given with one hundred drops of laudanum. The spasms on the abdominal muscles forced it from him immediately. His sensibility was so extremely increased, that opening a door, walking in his room, or speaking louder than a whisper, would produce spasms too distressing for language to express. Soon after the glister came from him, he had several free discharges; and a diarrhœa took place, which lasted through the day. In the evening, a julap of oil of cinnamon, and thirty drops of laudanum was given, which checked the discharges; but he passed a very restless night. Towards morning his spasms relaxed, and he slept a little.

Tuesday 15th. This morning he seemed tolerably easy. At 12 o'clock, a spasm seized his diaphragm and lungs.

Extreme difficulty of respiration came on. And he appeared to sink under his complaints; took his leave of his family; and made several arrangements respecting his property, and his funeral, with great composure: satisfied that, from the parts attacked, it was impossible for him to live but a few hours. Vesicating tincture of cantharides was applied on his breast; and a tea spoonful of Hoffman's anodyne mineral water was given him, without any effect. When life seemed just quitting him, a large discharge of flatus from the intestines, followed by a fetid discharge of excrement, gave immediate relief. An enema of a solution of cathartick salts was administered; which gave him two discharges. He seemed totally disappointed in being thus relieved; and considered it as a singular medical change.

At 7 o'clock in the evening, he took a large spoonful of Huxham's tincture of bark, with two spoonsful of wine; which proved very grateful. His pulse was very feeble, but his spasms seemed to have left him altogether. It was agreed, that he should repeat the last mentioned medicine every hour. He asked for cold cider, which he found very grateful to his taste. At 8 o'clock, he repeated the tincture of bark and wine; and asked to be turned in his bed, which was immediately done. He perceived a spasm, and called for a pillow to raise his head a little; which being placed agreeably to his wish, he stretched himself out during the spasm; and his respiration and pulse ceased instantly, without the least emotion. The medical gentlemen, who constantly attended him, supposed that a spasm seized his heart, which deprived him of life.

Wednesday morning. As it had been invariably his request, that, after his death, his foot might be examined, his family consented. The skin and cellular membrane were removed; and the nail could be traced to the sheath of the tendon, which was found to have been perforated; it did not enter the tendon; but passed by the side of it to the periosteum of the bone, which it had not affected.

Under the tendon was a small cavity, about the size of a pea, discoloured throughout, with evident marks of previous inflammation.

The phalanx of the toe was taken off; but no further discovery was made. From Wednesday, the 10th of September to his death, he never was without some medical friend in his chamber. And from Friday morning, he had two, and frequently three or four with him. His situation was such, that without some person well acquainted with the profession, his distress must have been exceedingly increased.

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ERRATA.

ERRATA.

Page 1, Line 11, for *Dantborne* read *Dunthorne.*
—— 3, —— 7, for *Star's* read *Sun's*
—— 6, —— 2, for *Ss* read *Sr.*
—— 7, —— 2, Divide the firſt number of the equation by 2, and for *Sr* read *sr.*
—— ——— 5, for ÷ log. 2, read — log. 2.
—— ——— 17, for *cosec Zs*, read *sine Zs.*
—— 32, —— 2, of the Example, for 69 43, read 69° 43′.
—— 80, —— 24, for "*fountains of deep*" read "*fountains of the deep.*"
Plate 1, Fig. 7, join *P. D.*

Obs. The "New method of working a Lunar Obſervation," publiſhed in the following Memoirs, was written several years ago, and before the publication of the tranſactions of the Royal Society for 1797, in which is inſerted a method ſomewhat ſimilar, invented by Mr. Mendoza y Rios. An appendix to the "New Practical Navigator," has lately been publiſhed, in which the corrections are all additive and the work is ſhorter.

MEMOIRS

AN

EULOGY,

ON

GENERAL GEORGE WASHINGTON.

QUÆ CÙM MAGNA MODIS MULTIS MIRANDA VIDETUR
GENTIBUS HUMANIS REGIO, VISENDAQUE FERTUR,
REBUS OPIMA BONIS, MULTA MUNITA VIRÛM VI:
NIL TAMEN HOC HABUISSE VIRO PRÆCLARIUS IN SE,
NEC SANCTUM MAGIS, ET MIRUM, CARUMQUE VIDETUR.

LUCRETIUS.

AN

EULOGY,

ON

GENERAL GEORGE WASHINGTON,

PRONOUNCED AT *BOSTON*,

ON WEDNESDAY, FEBRUARY XIX, MDCCC.

BEFORE THE

American Academy of Arts and Sciences,

BY THEIR APPOINTMENT, AND PUBLISHED AT THEIR REQUEST.

BY JOHN DAVIS,

MEMBER OF THE ACADEMY, AND OF THE
MASSACHUSETTS HISTORICAL SOCIETY.

BOSTON—{PRINTED BY W. SPOTSWOOD}—MDCCC.

AN

EULOGY,

ON

GENERAL GEORGE WASHINGTON.

In common inftances of mortality, when a Father or a Friend returns to duft, we do not take our final adieu, though the funeral rites be accomplifhed. Grief firft admits, then invites confolation, from converfing on the lives of the deceafed: a recapitulation of their virtues and of their meritorious actions is like Offian's mufic, at once, "pleafant and mournful to the foul."

When the Father of his Country; when a Nation's Friend defcends to the Grave, it is fit that public commemorations fhould mingle with private condolence: that

we ſhould frequently recal to view his revered image, and repeat our votive honors to him, who was never weary in contributing to our happineſs.

WITH ſuch impreſſions, my literary Fathers and Friends, you have appointed this ſolemn meeting: with ſuch impreſſions only, could I prevail upon myſelf to attempt the taſk, which it has been your pleaſure to aſſign to me.

DEATH has frequently taken a diſtinguiſhed victim from the circle of your aſſociation. You have mourned the loſs of the venerable BOWDOIN, your revered preſident, your liberal patron, the friend and promoter of all that was excellent and pure: the public ſpirited, the munificent HANCOCK: the claſſical, eloquent COOPER: CLARKE, in whom ſhone forth all the Beauties of Holineſs, whoſe pious lips were "wet with Caſtalian Dews:" BELKNAP, learned, devout, and unaffected, worthy of being the biographer of *WASHINGTON:* SUMNER, the cheriſhed Ornament of the Commonwealth: to theſe, and many more of your beloved and reſpected aſſociates you have bidden a ſad farewel: they are removed from your pleaſant meetings to the cold and ſilent manſions of the Grave. This day you lament the loſs of one, who was not indeed an attendant at your literary interviews; but who was ſtill moſt dear: whoſe benign and happy influences travelled to their object, unimpeded by diſtance, like the mild and ſteady beams of planetary light.

"THOU ſleepeſt the ſleep of Death, but we are not "unmindful of thee *O! Achilles:* in life and in death, thou art equally the object of our regard and veneration."

Thus ſang the Grecian Bard, to ſooth the ſhade of a Hero: with like affectionate reverence, with pious ſenſibilities, do we cheriſh thy memory, departed *WASHINGTON*, and pay repeated viſits to thy Tomb.

IN contemplating a life, whoſe maturer portion was ſo ſingularly ſplendent, we are naturally prompted to look back to its commencement. Correſponding to that conſiſtency of character, by which he was diſtinguiſhed, marks of ſuperiority are imprinted on the very threſhold of his days.

IN the early dawn of manhood, delicate and important public duties were committed to his charge. Then appeared ſome of thoſe heroic virtues, that preſaged his future greatneſs. Unſhaken fortitude, firm perſeverance, and ſound diſcretion. Behold the intrepid meſſenger purſuing his weary way through a pathleſs wilderneſs. The aſſaults of the ſavage do not intimidate him: the ſeverities of winter do not arreſt his progreſs. He returns in ſafety and in honor: though Gallic artifice ſtrewed his way with thorns: though the waters of the Allegany had well nigh extinguiſhed his valued life, when their impetuous current rolled over his youthful head.* Illuſtrious Man, then, as in all thy life, the conſcious ſatisfaction reſulting from a faithful diſcharge of duty, was thy ſufficient, thy beſt reward: but how might it have cheered thy exalted ſpirit to have known, that far beyond the limits of thy long and arduous journey ſhould extend an

* See his JOURNAL, publiſhed in the Maſſachuſetts Magazine, 1789.

Empire, which ſhould acknowledge thee, as the moſt diſtinguiſhed inſtrument of its eſtabliſhment.

THE ſame memorable ground next becomes the theatre of his military achievements; and at the early age of twenty-ſeven, he has attracted the admiration of his Country and retired to his beloved reſidence, with public teſtimonials of their approbation and regard.

AGRICULTURAL employments, domeſtic endearments, and the diſcharge of civic truſts dignify and adorn the next fifteen years of his intereſting life. But not theſe alone. In that calm interval, when common minds might have been corrupted by indulgence, or benumbed with ſatiety, the ſuperior mind of *WASHINGTON* was improving under the wholeſome regimen of ſyſtematic diſcipline. Faithful to the high obligations of truth and duty, faithful to himſelf, he ſtudied the various relations, that bind the man and the citizen, and, in the ſhade of peace and retirement, preſcribed to himſelf thoſe rules and maxims of conduct, on which was reared the lofty edifice of his fame.

WITH correct and extenſive views of the rights and intereſts of his country; with lively ſenſibilities, when they were invaded or endangered, he had a juſt title to the high honor of convening with that illuſtrious band of patriots and civilians, who compoſed the firſt national Council of United America. By that Council, faithful and intelligent, deeply impreſſed with the mighty intereſts intruſted to their care, and well apprized that the fate of their Country depended on their choice, he is unanimouſly appointed to command the feeble armies of an oppreſſed

people, againſt the veteran arms of the firſt European power. He ſuffers himſelf to be advanced to that "painful pre-eminence," though his ſtrong and comprehenſive mind could not have been unmindful of the vaſt "ſea of troubles," on which he was embarking.

WITH a leſs correct ſenſe of public duty, he might have urged many claims to avoid the ponderous taſk; and in a dubious conteſt, multitudes from political opinion, and many, from an indulgent regard to an opulent and diſtinguiſhed citizen, would have dignified the cautious deciſion, with the name of wiſdom. He liſtens to no ſuch unworthy ſuggeſtion. He takes counſel with himſelf—He obeys the call of his Country—He haſtens to the ſcene of action; and at no period, perhaps, does his conduct appear more elevated and intereſting, than at that impreſſive moment, when he placed himſelf at the head of his applauded band of *undiſciplined husbandmen*, on yonder claſſic plains.

THE purity and magnanimity, manifeſted by the acceptance of that arduous truſt, taught his admiring country to expect, with firm reliance, that, with thoſe hopeful pledges, were aſſociated all the protecting train of martial and of manly virtues.

THOSE animating hopes were completely realized. Modelled by his great example, the camp became a ſchool of virtue, as well as of military ſcience. There were ſeen unſhaken fidelity; unſullied honor; humane and ſocial ſympathies; pure love of country; reſpect for the magiſtracy, and reverence for the laws. He ſuſtained

the ſtandard of American Liberty with energies ſuited to her character: tempering authority with mildneſs, bravery with diſcretion.——Intrepid in danger, clement in victory, undiſmayed by diſaſter, he bore the precious depoſit through a long and perilous conflict, animated by the applauſes of a grateful country and the admiration of the World.

THE eventful occurrences, that developed his talents and his virtues, are too deeply impreſſed upon the memory of thoſe whom I addreſs, to require a repetition. They were ſtrongly aſſociated with all you held moſt dear. Revolving years, life's multiplied concerns, a long and happy participation of ſucceeding peace and proſperity, have not effaced them from your remembrance. And ye, ingenuous Youth, whoſe exiſtence commenced in the AGE of *WASHINGTON*, who have ſeen only his ſetting ſun, in the mirror of hiſtory you will behold the bright reflection of his meridian beams. You will learn of your revered ſires, how they were animated by their benign and cheering influence. Aſk of thoſe who bare you: they will tell you, how his guardian form diſpelled diſtreſſing terrors, and protected by his arm, with what calm complacence they watched your infant ſlumbers.

THE elevated ſentiments and the expanded views, which inſpired the mind of every active citizen, during the memorable conteſt for Liberty and Independence, were not ſatisfied with the firm purſuit, or the aſſured proſpect of thoſe intereſting objects. During a ſtruggle for political exiſtence, you ſtudied the liberal embelliſhments of a ſtate, and like PLINY on *Veſuvius*, attended to the

purſuits of Science, undiſmayed by the thunder and the ſtorm, by which you were aſſailed. This literary eſtabliſhment was a child of the revolution. Europe beheld it with admiration. The friends of America contemplated it with delight. They conſidered it as affording renewed evidence, that you were reſolved on the attainment of Freedom, and were worthy of its enjoyment.

THE illuſtrious Man, whoſe loſs we now deplore, was among the firſt of your elected aſſociates. It was a time of multiplied calamities. The military operations of the enemy were to be oppoſed in five different ſtates of the union. A mind occupied with ſuch immenſe concerns, could not be expected to apply itſelf to the immediate objects of your inſtitution. Yet he accepts your invitation; looking forward, doubtleſs, to the happier days, when the arts of peace ſhould ſucceed the horrors of war. As the firſt among the public characters of the age; as the pride and defence of your country, he was entitled to the earlieſt and moſt reſpectful expreſſions of your attention: but he was your aſſociate by ſtill more appropriate characters, by diſpoſitions and accompliſhments, altogether congenial to the nature and end of your inſtitution.

IT is among the declared objects of your inquiry, to examine the various ſoils of the country, to aſcertain their natural growths and the different methods of culture: to promote and encourage agriculture, arts, manufactures and commerce: to cultivate the knowledge of the natural hiſtory of the country, and to determine the uſes, to which its various productions may be applied.

Pursuits of this nature always commanded his attention, and to ſome of them he was peculiarly attached. They were frequently the topic of his converſation, and the ſubject of his correſpondence, with ingenious and public ſpirited men, in different parts of the world.

With a mind well-fitted to acquire juſt conceptions on any ſubject, to which his attention was directed, he would, I am perſuaded, have been diſtinguiſhed in the abſtruſer branches of ſcience, if the courſe of life, which he had choſen, or to which he was impelled, had not been incompatible with the purſuit. In patient inveſtigation, unwearied aſſiduity, and ſyſtematic arrangement, he was excelled by none. The uniform ſucceſs, which attended his operations in military and political life, evinces great ſolidity of judgment: and he, who could produce ſuch correct and proſperous reſults, in the great affairs of a nation, ſo liable to be defeated or impeded, by the ever varying humours and prejudices of men, with like application, might have been equally diſtinguiſhed in the ſteady regions of ſcience, whoſe permanent relations and connected truths, never fail to diſcloſe themſelves to induſtrious reſearch and attentive contemplation.

But though a man of contemplative habits, he was ſtill more fitted for action. It became neceſſary for the repoſe and happineſs of his country, that he ſhould leave *the aſylum of his declining years*. Obedient to that voice, which he could never hear but with *veneration and love*, he exchanges a retreat which he had choſen with the

fondest predilection, for the anxieties and toils of political elevation. How was he honored in the midſt of the people, in coming forth from the ſhades of his retirement. "He was as the morning ſtar in the midſt of a cloud; "and as the moon at the full; as the *sun*, ſhining upon "the temple of the MOST HIGH; and as the rainbow, "giving light in the bright cloud."*—

THE duties of an employment, which is accepted with reluctance, are frequently diſcharged with ſymptoms of wearineſs or diſguſt: but he engaged in the multiplied labours of his new and arduous ſtation, as if it were the fond object of his choice; and though enjoying a weight of character, which would peculiarly facilitate his meaſures, yet he diſcovered a laudable ſolicitude, that they ſhould poſſeſs an intrinſic propriety, and conducted himſelf with as much caution and circumſpection, as if he were for the firſt time a candidate for public favour.

THE intereſting objects of his care, and their direct and intimate connexion with the ſolid intereſt and permanent welfare of his country were indeed congenial to the beſt wiſhes of his heart, and fitted to relieve the unavoidable ſolicitudes of his ſtation. To regard with comprehenſive and equal eye the great aſſemblage of communities and intereſts over which he preſided: to ſettle pure and ſolid foundations of national policy, conſiſtent with the eternal rules of order and right which Heaven has ordained: to eſtabliſh public credit: to revive mutual confidence: to introduce with the native tribes on the frontiers, a ſyſtem, correſponding with the

* ECCLESIASTICUS.

mild principles of religion and philanthropy: to provide for the national ſecurity, by ſuitable military eſtabliſhments: to found the ſafety of the United States, on the baſis of ſyſtematic and ſolid arrangement: to guard againſt infractions of the laws of nations: to maintain a friendly intercourſe with foreign powers: to exhibit that ſtability and wiſdom in the public counſels, which ſhould be a juſt ground of public confidence: to adopt meaſures for the accompliſhment of *our* duties to the reſt of the world, and create a capacity of exacting from them the diſcharge of *their duties* towards us: to maintain to the United States their due rank among the nations of the Earth: to vindicate the majeſty of the laws, againſt violence and inſurrection: to turn the machinations of the wicked to the confirming of the conſtitution: to extinguiſh the cauſes of external differences, on terms compatible with national rights and national honor: to mingle in the operations of government every degree of moderation and tenderneſs, which national juſtice, dignity and ſafety might permit, and to exemplify the pre-eminence of a free government, by all the attributes, which might win the affections of its citizens and command the reſpect of the world.*—Theſe were the momentous purſuits, which occupied his elevated mind, and engaged his warmeſt affections: for theſe purpoſes, he invited the aid and co-operation of the enlightened counſels of the Union; and, in ſpite of the petulance of oppoſition, or the effuſions of faction, his proſperous

* See WASHINGTON's Speeches to Congreſs, from which the above ſummary of his preſidential purſuits is ſelected, with little variation from his own impreſſive language.

country and its grateful inhabitants, will teſtify that they have been accompliſhed.

WITH views and occupations, ſo comprehenſive and elevated, he did not loſe ſight of *Learning* and of the *Arts*. "There is nothing," ſaid he, (in his addreſs to the firſt congreſs) "that can better deſerve your attentive "patronage, than the promotion of Science and Literature. "Knowledge is in every country, the ſureſt baſis of public "happineſs. In *one*, in which the meaſures of government "receive their impreſſion ſo immediately from the ſenſe of "the community, it is proportionably eſſential." To the Truſtees and Faculty of the Univerſity of Pennſylvania, in reply to their reſpectful addreſs, he acknowledges himſelf gratified *in being considered, by the patrons of literature, as one of their number;* being *fully apprized of the influence which sound learning has on religion and manners, on government, liberty and laws;* and expreſſing his confidence that *the same unremitting exertions, which under all the blasting storms of war, caused the arts and sciences to flourish in America, would bring them nearer to maturity, when invigorated by the milder rays of peace.* To the Univerſity of Harvard, he communicates *his sincere satisfaction in learning the flourishing state of their literary republic. Unacquainted,* he adds, *with the expression of sentiments which I do not feel, you will do me justice in believing, confidently, in my disposition to promote the interests of science and true religion.*

HIS cloſing addreſs to Congreſs is enriched with like paternal ſentiments; and at a more ſolemn moment, when completing the laſt arrangement of his terreſtrial

concerns, he makes careful provifion for a literary eftablifhment which he had before emphatically recommended; appropriating to the inftitution of a NATIONAL UNIVERSITY a very liberal donation, which his native ftate, as an expreffion of their grateful fenfe of his fervices, had placed at his difpofal.

THESE expreffions of his fentiments and views indicate the character, which he would probably prefer to fuftain. Not merely that of a warrior, or ftatefman; but as the enlightened friend of man, and all his beft enjoyments: the advocate of religion: the fupporter of virtue: and, to adopt the language of your charter, the cultivator or patron of "every art and fcience which "may tend to advance the intereft, dignity and happinefs "of a free, independent and virtuous people."

THE artift who executed the ftatue which adorns the capital of Virginia, had juft conceptions of the moft appropriate character and attitude. Its fimple *costume*, is well adapted to defignate the founder and defender of American Liberty: the protector of agriculture: the reprefentative of a happy and peaceful nation.*

IT would require little aid from the imagination, to render the fignificant emblem of your fociety an apt memorial of your late illuftrious affociate. Let MINERVA, with the fpear and fhield, reprefent his venerable form. The implements of hufbandry, the hill crowned with oaks, and the field of native grain, indicate his favorite employment. The rifing city, the inftruments of philofophy, the approaching fhip, and the fun above the cloud, are lively images of the benign and happy influ-

* Anecdotes of the Sculptor HOUDON. Month. Mag. Sept. 1798.

ence of his life, on commerce and the arts, and the advancing greatneſs of his country.

WHILE contemplating the character of *WASHINGTON*, in a literary point of view, I muſt not omit to conſider his ſtyle. It is diſtinguiſhed for purity, propriety, and preciſion; and ſome of the moſt correct philologiſts have pronounced, that moſt of the qualities of a good ſtyle are united in his compoſitions. In his letters he is plain: in his public addreſſes elegant: in all he is correct, expreſſing in a ſmall compaſs his clear conceptions, without tireſome verboſity, or any parade of ornament. In attending to what has fallen from his pen, the connexion between modes of thinking and writing; between character and compoſition is apparent. His writings are marked with the ſtrong and pleaſing features of ſincerity, ſimplicity and dignity.

IT is the complaint of LIVY, that eulogies, though an uſeful incitement to great and virtuous actions, tend to corrupt the truth of hiſtory. In this regard, I have no apprehenſions. I have aſcribed no excellencies to the elevated character, which I have attempted to ſketch, that you are not witneſſes he poſſeſſed: but I ſenſibly feel, how imperfect will be the picture, which I ſhall have exhibited. With great ſincerity, ſhall I adopt the *ſuſpenſive inſcription* of the Grecian artiſts, expreſſing that they were employed in the execution of ſuch a ſtatue or picture, rather than that they had in any degree finiſhed it *.

* HARRIS's HERMES.

An admired writer, ſpeaking of the caſual reſemblances of perſons and things, obſerves that in the revolution of ages, the wheels of Fortune, will after a long interval run in the ſame track. I addreſs myſelf to men, to whom the tranſactions of paſt ages are familiar, who have been accuſtomed to examine and to eſtimate the ſplendid characters that have attracted the attention of the world. Permit me to inquire if you have found the man, who in merit and in fame, in all the genuine ingredients of true glory and ſolid happineſs, can be compared with our lamented Chief.

That raſhneſs and exceſs, which tarniſh the fame of *Macedonia's Madman and the Swede*, appear in many of the heroes of ancient and modern ſtory. Some unworthy propenſity, or ſome unhappy error is perceived amidſt all the effulgence of their glory. Pompey could win the affections of the ſenate and the people of Rome, by diſbanding his victorious armies and reaſſuming the humble air and deportment of a private citizen: but he could alſo deſcend to corrupt the people with money; to employ the vileſt citizens to embarraſs the magiſtrates in the execution of their functions, that his interpoſition might be rendered neceſſary by commotion: verifying the juſtice of the remark, that he could not reſolve to uſurp power; but would have been glad to have had it tendered to him as a gift *.

The celebrated reign of the philoſophic emperor Marcus Antoninus is clouded by the indiſcreet adoption of Commodus, and his too great indulgence of the

* Monteſq; Grand. & Decad. &c.

infamous FAUSTINA; by the elevation of her lovers to pofts of honor; by decreeing her deification, and requiring the youth of Rome to pay their vows before her altars.

To the firft PETER of Ruffia, the title of GREAT has been more permanent, than in moft inftances, in which it has been affumed or beftowed: but we are fhocked at the recorded inftances of his cruelties, and he is quoted by a celebrated theorift,* to exemplify the exiftence of public fpirit, without the fpirit of humanity.

VICTOR AMADEUS, with apparent magnanimity, refigned his crown to his fon, and fought the placid enjoyments of privacy and retreat. But his retirement became irkfome to him: he languifhed for the re-enjoyment of power, caballed againft his fon and ended his days in a prifon.

A LOUIS XIV. and a FREDERIC, with all the fplendor of their lives, died without exciting any regrets: and a MARLBOROUGH, famed for his confummate prudence, as well as for his military achievements, was accufed of the meannefs of avarice, and of protracting a fanguinary war for the enlargement of property and power.

IF I were to felect the character, among the great men of antiquity, exhibiting the neareft refemblance to *WASHINGTON*, it would be TIMOLEON; memorable for the defence and deliverance of *Sicily*, from external and internal foes; for the eftablifhment of civility and order; and for the quiet enjoyment, to a revered

* ADAM SMITH'S THEORY OF MORAL SENTIMENTS.

and honorable old age, of the rewards of his virtuous labors, in the bofom of a grateful people. To that degree did he enjoy the affection of the Sicilians, fays his biographer, that no war feemed concluded, no laws enacted, no political regulation made in a proper manner, unlefs revifed and touched by him. He was the mafter-builder who put the laft hand to the work, and beftowed upon it a happy elegance and perfection; though at that time Greece boafted a number of great men, whofe achievements were highly diftinguifhed. TIMOTHEUS, AGESILAUS, PELOPIDAS and EPAMINONDAS, (the laft of whom TIMOLEON principally vied with in the race of glory) yet in this they differ from TIMOLEON, that we difcover in their actions a certain labor and effort which diminifhes their luftre, and fome of them afforded room for cenfure, and were followed by repentance or remorfe.

HIS trophies coft his fellow citizens no tears, nor put any of them in mourning; and yet, in lefs than eight years he delivered SICILY from its inteftine miferies and diftempers, and reftored it to the native inhabitants. His military labors finifhed, he returned to SYRACUSE, and laid down his command; excufing himfelf to the people from any further fervice, as he had brought their affairs to a happy conclufion. His old age was cherifhed, as that of a common father. He died of a flight illnefs, co-operating with length of years. His funeral was attended by many thoufands of men and women, crowned with garlands, and clothed in white. The lamentations mingled with the praifes of the deceafed, evinced that

the honors paid him was not a matter of courſe, or in compliance with a duty enjoined, but the teſtimony of real ſorrow and ſincere affection *.

In this deſcription, the analogy, which I have ſuggeſted is apparent. In other particulars, there is no reſemblance. TIMOLEON was a foreigner in SICILY. *WASHINGTON* had the ſupreme ſatisfaction of imbibing and diſplaying all his virtues and talents, in his own beloved country. As if to exemplify his own ſage reflections upon the inexpediency of foreign education and accompliſhments for an American citizen, he like

"The tall maſt that bears our Flag on high,
"Grew in OUR SOIL and ripen'd in OUR SKY." †

TIMOLEON was long wretched, if not guilty in the death of his brother, and was a prey to ſorrow and remorſe for the ſpace of twenty years. No baleful domeſtic occurrence darkened the days of *WASHINGTON*. Troubles and anxieties, inſeparable from the cup of life, doubtleſs aſſailed him; but thoſe he ſuſtained with dignity and equanimity.

TIMOLEON was cenſurable in cauſing the condemnation and the death of the wife and daughter of ICETAS.

THE tender ſympathies of humanity were always cheriſhed in the breaſt of *WASHINGTON*; and in a war peculiarly tending to kindle and inflame the human paſſions, he is chargeable with no inſtance of cruelty or revenge.

* PLUTARCH'S LIFE OF TIMOLEON.
† J. ALLEN'S POEMS.

TIMOLEON was blind and helplefs in his old age, and the refpect with which he was regarded was mingled with pity; reminding us of LUCAN's image of an aged tree, cafting a fhade only by its trunk. The declining years of *WASHINGTON* were without apparent decay. He feemed like the mountain oak; and to the laft, we looked for fhelter beneath its branches, againft the impending ftorm.

IN ftudying the character of *WASHINGTON*, we cannot refrain inquiring, by what principles or motives he was thus uniformly fwayed to the practice of virtue and the fteady purfuit of excellence. Much doubtlefs was due to his habitual refpect for the approbation and efteem of his fellow citizens: and in attributing the formation of his character and fame, in any degree, to this fource, we pay a juft tribute to his countrymen, a tribute, which he was ever prompt to beftow. It was owing to their *steady and strenuous support*, he acknowledges, that he did not *sink under the oppression* which occafionally affailed him. "Pofterity," faid he, "will regard with admiration "and gratitude the patience, perfeverance, and valor, "which achieved our revolution: they will cherifh the "remembrance of virtues, which had but few parallels "in former times, and which will add new luftre to the "moft fplendid pages of hiftory*."—On fuch expreffions, he appears to dwell with delight. Thus did PYRRHUS acknowledge his obligations to the EPIROTS, when honored by them with the name of the EAGLE. *If I am an EAGLE*,

* ANSWER to the PEOPLE of SOUTH CAROLINA, 1790.

ſaid he, *it is upon your arms—upon your wings that I have risen.*

To this motive was added that delicate and refined MORAL SENSE, which is the guardian and protectreſs of all the virtues: which forbids committing any thing baſe or unworthy; any thing unbecoming the dignity of man, a due reverence for himſelf, and the rank he holds in the ſcale of rational beings.

BUT above all, he was influenced by the more permanent and operative principle of Religion: by the firm and active perſuaſion of an *ALL-SEEING*, *ALL-POWERFUL DEITY*: by the high conſciouſneſs of future accountability and the aſſured hope and proſpect of Immortality. Contraſting his ſublime example, founded on ſuch a baſis, with the tribe of infidel heroes, who have lately appeared on the bloody theatre of EUROPE, we cannot but apply the impreſſive language of a ſober and intelligent heathen. "Earthquakes, lightning, ſtorms "and torrents have an amazing power: but as for "JUSTICE nothing participates of THAT, without thinking "and reaſoning upon *GOD*."

SOUND ſcience will ever be found promotive of rational religion and the ſolid intereſts of the Commonwealth: but there is a *leprosy of false knowledge*, which is akin to impiety, and ſaps the compacted fabric of ſocial order. It is thus in the political ſyſtem. The mild and lovely form of *TRUE LIBERTY*, is oppoſed by a harlot bluſtering counterfeit.

IT is the pride of this Society, it is the glory and felicity of the Nation, to have at their head A MAN, to

whom the knowledge and the practice of the GOOD and the TRUE are perfectly familiar: whom no falfe theories can delude, no deceptive inticements feduce, no demons of mifchief difmay.

UNDER fuch aufpices, you will walk fafely and fuccefsfully: preferring the fober paths of practicable good to the brilliant allurements of feductive unfubftantial novelties: adhering to old and approved truths, while indulging in new inquiries: folicitous for improvement, but ftill retaining a juft reverence for the approved maxims of ancient prudence. Let us hope that the cafual abufes of Science, or the exentricities of fome of its profeffors, will not impede its cultivation and encouragement. Falfe philofophy is indeed the deceitful DELILAH, which will enervate and corrupt the ftrongeft eftablifhments and deliver them nervelefs, and refiftlefs, to the *Philistines of Infidelity*, the Lords of Anarchy and Mifrule: but found Science, with rational Religion, will be the firm fupporters of the Magiftracy to the lateft time; as AARON and HUR fuftained the hand of MOSES, *until the going down of the sun.*

No. I.

A method of finding the Area of a field arithmetically, by ELIZUR WRIGHT, A. M.

THE inveſtigation of the area of a field, performed according to the two modes of operation, Geometrical and Arithmetical, has in each its peculiar excellences and defects. The lines and figures, ariſing in a geometrical operation, aſſiſt the imagination, and give an exact image and idea of the form of the field. The operation is at the ſame time eaſy and expeditious. But the arithmetical method is capable of a higher degree of accuracy, and enables us to approach to a greater nearneſs to truth. The minutes of a degree, or the decimal parts of a chain, when geometrically conſidered, approach ſo near to a point, that it often becomes impracticable to lay them down on paper; which occaſions a ſenſible error in the operation, ſo that ſurveyors will frequently differ very conſiderably in computing the area of the ſame field. For theſe reaſons it will be doing an acceptable ſervice to furniſh the ingenious artiſt with an univerſal method of finding the area of a field by numbers, that ſhall exhibit an eaſy and natural order, ſo that the operator may proceed without perplexity or danger of miſtake: and alſo afford a ſhort and concinnous ſolution, performed with the leaſt poſſible number of figures. Having had occaſion to turn my thoughts to the computation of areas, I hit upon a numerical method of finding

ing the area of a field, which I ſhall attempt to communicate, as it occurred to me, in the following manner :

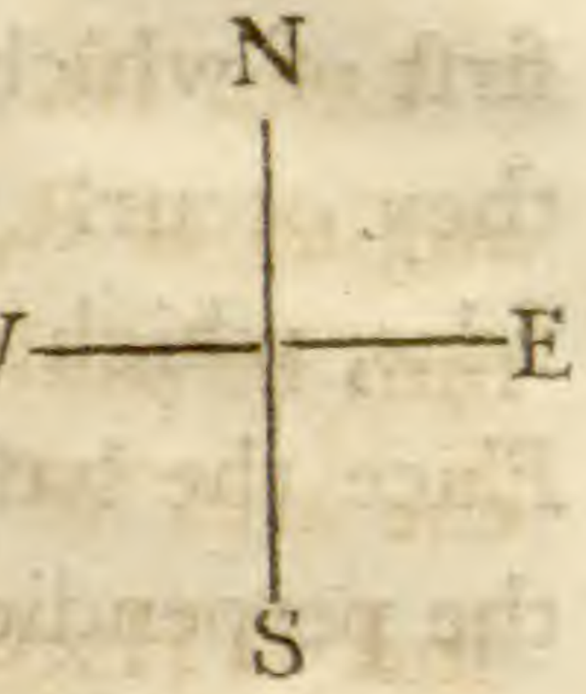
Let it be ſuppoſed that the ſides A B, B C, C D, D A, (Plate I. fig. 6,) of a field are hypothenuſes of right angled triangles, the baſes of which are eaſt and weſt lines, and are either eaſtings, as E B, F C, or weſtings, as G D, H A ; and the perpendiculars north and ſouth lines, being either northings, as A E, B F, or ſouthings as C G, D H according to the bearings of the ſides. The eaſtings, weſtings, northings, and ſouthings are denoted by the initial letters E. W. N. S. in the expreſſion of the courſe. The *calculatrix* is an eaſt and weſt line, which may poſſeſs any aſſignable place E W, ew (Plate I. fig. 7,) *ad libitum* : but to ſhorten the operation it is ſuppoſed to biſect the firſt ſide, with which the operation commences. A perpendicular line C O, drawn from the further extremity of a ſide B C to the calculatrix, is the ultimate *calculatral diſtance* of that ſide ; and a perpendicular S M, drawn from the middle of a ſide B C, is the *mean calculatral diſtance* of that ſide. In the following method the calculatral diſtance is taken double. To the triangle A B N add the trapezium N B C O ; the ſum is the area A B C O ; from which ſubtract the trapezium O C D P, and it leaves the area A B C D P ; and from this ſubtract the triangle P D A, and the remainder is the area of the field A B C D. The areas of theſe triangles and trapezia, and from thence the area of the field may be obtained by the following

2 RULE.

RULE.

Make a divifion in the field book of two columns; in the firft of which note down the courfes and fides of the field, as they occur. Find the bafes and perpendiculars of the feveral fides, which may be expeditioufly done by the help of a table. Place the bafes in the firft column underneath the fides, and the perpendiculars in the fecond column, prefixing the *fign* — to thofe that are *fouthings*. Let the *calculatrix* be confidered as *bifecting* the *firft fide*; then the *mean calculatral diftance* of the *firft fide* is *equal to O*; and its *perpendicular* is equal to its *ultimate calculatral diftance*. When they are *both northings*, or *both fouthings*, take the *fum* of the *ultimate calculatral diftance* of the firft fide, and the *perpendicular* of the fecond; and it will be the *mean calculatral diftance* of the fecond fide. Again, take the *fum* of the aforefaid *perpendicular* and *mean calculatral diftance*; and it will be the *ultimate calculatral diftance* of the fecond fide. But when they are, *one a northing* and the *other a fouthing*, take their *difference* inftead of fum. Here let it be obferved, that the mean and ultimate calculatral diftance is of the fame name with the number added to, or fubtracted from; and when it is a fouthing, it muft be defignated by prefixing the fign — to it. In like manner proceed with each of the remaining fides. Multiply the *mean calculatral* diftance of each fide by its *bafe*. Then bring the feveral products, whofe factors are northings and eaftings, or fouthings and weftings, into one fum: likewife bring the products, whofe factors

factors are northings and weftings, or fouthings and eaftings, into another fum. To affift the memory let the annexed diagram reprefent the cardinal points; and let it be conceived, that the products, to be brought into one fum, have their factors in the order W N E, S W; and that thofe, to be brought into the other fum, have their factors in the contrary order N W, S E. Laftly take the *difference* of thefe *fums*; *half* of which will be the required *area* of the field.



EXAMPLE I.

C. S. B.	P.
S. 69° 43′ W. 21 12 19 81	—7.32 0.00 —7.32
N. 55° E. 18 14 74	10.32 3.00 13.32
S. 42° W. 6 4 01	—4.46 8.86 4.40
N. 64° E. 12 10 78	5.27 9.67 14.94
S. 24° W. 4 17 1 70	—3.81 11.13 7.32
25 52 25 52 N E. S W. 44.2200 104.2426	N W. S E. 35.5286 18.9210
148.4626 54.4496	54.4496
94.0130 47.0065	

Suppofe the furvey of a field to be as follows: From the firft boundary S. 69° 43′ W. 21.12 chains: thence N. 55° E. 18 chains: thence S. 42° W. 6 chains: thence N. 64° E. 12 chains: thence S. 24° W. to the firft boundary. The required area is 47.0065 chains, or 4.70065 acres.

When the fum of the eaftings is equal to the fum of the weftings, and the fum of the northings is equal to the fum of the fouthings; which is known by the ultimate calculatral diftance of the laft fide being equal to the perpendicular of the firft fide, but of a different name, the furvey is rightly taken; otherwife there is an error either in the courfes, or fides.

In

In order to demonſtrate this numerical method of finding the area, I ſhall lay down the following Lemmas.

Lem. 1ſt. In the trapezium R G H Q (Plate I. fig. 8,) right angled at R, and Q; if to twice G R be added O H, and this ſum be multiplied by G O, the product will be equal to twice the area of the trapezium. For $2\ GR\times GO=2\ RGOQ$, and $OH\times GO=2\ GHO$. Therefore $\overline{2\ GR+OH}\times GO=2\ RGHQ$. Q. E. D.

Lem. 2d. In the foregoing trapezium if from twice H Q be ſubtracted H O, and the remainder be multiplied by G O, the product will be equal to twice the area of the trapezium. For $2\ HQ\times GO=2\ RAHQ$, and $HO\times GO=2\ GAHO$. Therefore $\overline{2\ HQ-HO}\times GO=2\ RGHQ$. Q. E. D.

Lem. 3d. In figure 9th, plate I. if the triangle C F L be made equal to the right angled triangle B O K, then M L multiplied by K M will be equal to twice the area of the trapezium O F L M. For $ML\times KM=OFLM+OFAK=2\ OFLM$. Q. E. D.

The diagram A B C D E (Plate I. fig. 10,) is a geometrical conſtruction of the foregoing example. K Q is the calculatrix. K M, D T are eaſtings, and I K, N D, P A are weſtings. B K+M C, T E are northings, and A I+K B, C N, E P are ſouthings. C M, D R, E Q, A I are the calculatral diſtances of the ſides B C, C D, D E, E A. The operation according to the conſtruction is as follows.

NE,

C. S. B.	P.
S. 69° 43′ W. A B.	—AI—KB
	O
IK	—AI—KB
N. 55 E. BC	BK+MC
	LM
KM	2 CM
S. 42 W. CD	—CN
	2 CM—CN
ND	2 DR
N. 64 E. DE	TE
	2 DR+TE
DT	2 EQ
S. 24 W. EA	—EP
	2 EQ—EP
PA	AI+KB

NE, SW.

2 OFLM ($=\overline{ML}\times KM$ by Lem. 3.)

2 DEQR ($=\overline{2\,DR+TE}\times DT$ by Lem. 1.)

NW, SE.

2 CDRM ($=\overline{2\,CM-CN}\times ND$ by Lem. 2.)

2 EAIQ ($=\overline{2\,EQ-EP}\times PA$ by Lem. 2.)

OFLM+DEQR—CDRM—EAIQ=ABCDE.

DEMONSTRATION.

OFLM+FCL=OCM.

OCM—CDRM=OCDR.

OCDR+DEQR=OCDEQ.

OCDEQ—EAIQ=OCDEAI.

OCDEAI=OCDEABK.

OCDEABK—BOK=ABCDE.

Hence by ſubſtitution

OFLM—CDRM+DEQR—EAIQ=ABCDE.

Q. E. D.

EXAMPLE

EXAMPLE 2.

C. S. B.	P.	N E. S W.	N W. S E.
N. 40E. 10 6.43	7.66 0.00 7.66	93.7388 5.9826 15.7384	32.8680 .7398 17.5200
N. 56W. 4 3.32	2.24 9.90 12.14	115.4598 51.1278	51.1278
S. 80E. 9 8.86	—1.56 10.58 9.02	64.3320 Area is 32.1660	
S. 25E. 8 3.38	—7.25 1.77 —5.48		
N. 36W. 7 4.11	5.66 .18 5.84		
W. 3 3.00	0.00 5.84 5.84		
S. 1 0	—1.00 4.84 3.84		
S. 55° 9′ W. 10 04 8.24	—5.75 —1.91 —7.66		
18.67 18.67			

No. II.

A method of finding the area of a Field by east and west areas.

Assume 10, or 100, or 1000 according to the dimensions of the field for the mean calculatral distance of the first side. Add the perpendicular of the first side, if a northing to its mean calculatral distance; and the sum is its ultimate calculatral distance. But if the perpendicular is a southing, subtract instead of adding. The perpendicular of each of the remaining sides

ſides muſt be *twice added* if a *northing*, but if a *ſouthing*, *twice ſubtracted* from the ultimate calculatral diſtance of the preceding ſide ; the *firſt* obtains the *mean calculatral diſtance*, and the *ſecond* the *ultimate calculatral diſtance* of that ſide. Multiply the *mean calculatral diſtance* of each ſide by its *baſe*. Then take the *difference* of the *Eaſt* and *Weſt* products or areas, *half* of which will be the required *area* of the field.

EXAMPLE.

C. S. B.	P.	E. Areas.	W. Areas.
S. 69 43 W. 21 12 19 81	—7.32 10.00 2.68	191.6200 212.0426	198.1000 75.6286 35.9210
N. 55E. 18 14.74	10.32 13.00 23.32	403.6626 309.6496	309.6496
S. 42W. 6 4.01	—4.46 18.86 14.40	94.0130 Area is 47.0065	
N. 64E. 12 10.78	5.27 19.67 24.94		
S 24W. 4.17 1.70	—3.81 21.13 17.32		
25.52 25.52	10.00		

No. III.

A general ſolution of the problem to find the area of an irregular polygon, having the ſides and angles given.

Let the ſeveral ſides of the polygon A B, B C, C D, D E, E A (Plate I. fig. 11,) be conſidered as hypothenuſes of right angled triangles, of which the perpendiculars B F, C G, D H, E I are parallel to the prime ſide A B, or the ſide with which the operation

ation begins. Alſo let the given angles A B C, B C D, C D E, &c. be exchanged for the angles F B C, G C D, &c. Theſe angles of *commutation* are obtained by methods hereafter deſcribed. In order to perform the operation, the ſeveral poſitions of the baſes, and perpendiculars, muſt be diſcovered, and deſignated. The perpendiculars on one ſide of the baſes, as F B, G C are denoted by A; and the perpendiculars on the oppoſite ſide, as H D, I E by B, prefixed to the angle of commutation. Likewiſe the baſes on one ſide of the perpendiculars, as F C, G D are denoted by A; and the baſes on the oppoſite ſide, as H E, I A by B, ſuffixed to the angle of commutation. It is evident, that when a ſide happens to be at right angles with the prime ſide, the hypothenuſe and its baſe become equal; and when a ſide is parallel with the prime ſide, the hypothenuſe and its perpendicular become equal: and in the former caſe the perpendicular, and in the latter the baſe and angle of commutation evaniſh, and become equal to O. Yet for the ſake of diſcovering the poſitions of the ſequent baſes, and perpendiculars, they muſt be retained, and brought into the calculation. For this end they may be conſidered as indefinitely ſmall quantities, or quantities leſs than any aſſignable one; and will therefore be expreſſed by O. Place either A, or B before, and either A, or B after the evaneſcent angle of commutation belonging to the prime ſide. Then the an-

gles of commutation may be found by the following rule, which contains two cafes.

CASE I. When the letters affixed to the angle of commutation laft found, are the *fame.*

Take the *fum* of the angle of *commutation* laft found and the *given* angle, if the given angle be *inward:* but if it be *outward*, take their *difference.*

CASE II. When the letters affixed to the angle of commutation laft found, are *different.*

Take the *difference* of the angle of *commutation* laft found and the *given* angle, if the given angle be *inward:* but if it be *outward*, take their *fum;* and the refult is denominated the *factum.* In both cafes when the factum is lefs than 90, it is the angle of commutation fought: but when it exceeds 90, fubtract it from 180; and when it exceeds 180, fubtract 180 from it, and the remainder will be the required angle of commutation.

Nextly the pofitions of the bafes and perpendiculars may be eafily difcovered from the foregoing operation by infpection thus:

CASE I. When the factum is *lefs* than 90.

PROP. 1. If the angle of *commutation* be *fubtracted* from the *given* angle, the letters prefixed to the two angles of commutation laft found, will be *unlike*, and the letters fuffixed will be *like.*

PROP. 2. If the angle of *commutation* be *not ſubtracted* from the *given* angle, the letters prefixed will be *unlike*, and the letters ſuffixed *unlike*.

CASE II. When the factum is *greater* than 90.

PROP. 1. If the *ſum* of the angle of *commutation* and *given* angle be *ſubtracted* from 180, the letters prefixed will be *like*, and the letters ſuffixed *unlike*.

PROP. 2. If the aforeſaid *ſum* be *not ſubtracted* from 180, the letters prefixed will be *like*, and the letters ſuffixed *like*.

When the factum is 90, it may be conſidered as belonging either to Caſe I, or Caſe II ; and when the factum is 180, it may be conſidered as belonging either to Caſe II. Prop. 1, or Caſe II. Prop. 2, ad libitum ; each ſuppoſition leading to a true diſcovery of the poſitions of the ſubſequent baſes and perpendiculars.

The *calculatrix* is a line K L (Plate I. fig. 12.) biſecting the ſecond ſide B C, and at right angles with the prime ſide A B.

A perpendicular D L drawn from the farther extremity of a ſide C D to the calculatrix, is the ultimate *calculatral diſtance* of that ſide.

A perpendicular M S, drawn from the middle of a ſide C D, is the *mean calculatral diſtance* of that ſide.

In the following method the calculatral diſtance is taken double.

double. Find the bafes and perpendiculars of the feveral fides; placing the bafes in the fecond column underneath the fides, and the perpendiculars in the third column. Prefix the *negative fign* — to thofe bafes and perpendiculars, whofe pofitions are defignated by *B*. Paffing over the prime fide, the *mean calculatral diftance* of the *fecond* fide is *equal to O*; and its *perpendicular* is equal to its *ultimate calculatral diftance*. Take the *fum* of the *ultimate calculatral diftance* of the fecond fide, and the *perpendicular* of the third according to the rules of Algebra, and it will be the *mean calculatral diftance* of the third fide. Again take the *fum* of the aforefaid *perpendicular* and *mean calculatral diftance*, and it will be the *ultimate calculatral diftance* of the third fide. In like manner proceed with each of the remaining fides. Multiply the *mean calculatral diftance* of each fide by its *bafe*: then *half* the Algebraic *fum* of thefe products will be the required *area* of the polygon. It may here be obferved, that when the work is done right, the angle of commutation for the laft fide is equal to the given angle at the beginning of the operation: alfo the fum of the affirmative bafes is equal to the fum of the negative bafes; and the fum of the affirmative perpendiculars is equal to the fum of the negative, which is the cafe, when twice the perpendicular of the prime fide being added to the ultimate calculatral diftance of the laft fide, the refult is equal to the perpendicular of the fecond fide, but of a contrary value.

EXAMPLE

EXAMPLE I.

A.	S. B.	P.
14°. 43′ A. 0 A.	18 0	18
13° B. 13 B.	6 —1.35	—5.85 0.00 —5.85
22°∠ A. 9 B.	12 —1.88	11.85 6.00 17.85
40° B. 31 B.	4.17 —2.14	—3.57 14.28 10.71
134°. 17′ 165. 17 B. 14. 43 A.	21.12 5.37	—20.43 —9.72 —30.15
	5.37 5.37	36.00 5.85

—11.2800
30.5592
52.1964
———
94.0356

Area is
47.0178.

EXAMPLE 2.

A.	S. B.	P.
15° 4′ B. 0 A.	10 0	—10
84°∠ A. 84 B.	4 —3.98	.41 .00 .41
24° B. 60 A.	9 7.79	—4.50 —4.09 —8.59
125° A. 65 A.	8 7.25	3.38 —5.21 —1.83
11° B. 76 B.	7 —6.79	—1.69 —3.52 —5.21
126°∠ A. 50 B.	3 —2.30	1.93 —3.28 —1.35
90°∠ 140 A. 40 A.	1 64	.77 —.58 .19
124°. 56′ 164. 56 A. 15. 4 B.	10.04 —2.61	9.70 9.89 19.59
	15.68 15.68	—20.00 —.41

+23.9008
7.5440
———
31.4448

—31.8611
37.7725
0.3712
25.8129
———
95.8177
31.4448
———
64.3729

Area is
32.1864

EXAMPLE I.

In the Polygon A B C D E there is given the angles E A B =14° 43′, A B C=13°, B C D=22°∠, C D E=40°, D E A= 134° 17′; and the ſides A B=18, B C=6, C D=12, D E=4.17, E A=21.12; required the area.

EXAMPLE 2.

In the polygon A B C D E F G H there is given the angles H A B=15° 4′, A B C=84°∠, B C D=24°, C D E=125°, D E F =11°,

=11°, EFG=126°∠, FGH=90°∠, GHA=124° 56′; and the ſides AB=10, BC=4, CD=9, DE=8, EF=7, FG=3, GH=1, HA=10.04; required the area.

The magnetical needle is found to vary ſeveral minutes from a true traverſe. This is occaſioned by friction. Where a great accuracy therefore is required in taking the ſurvey of a field, this general rule for finding the polygonal area may be very advantageouſly applied. For this end take the menſuration of the including angles of the field, independent of the needle, which may be done with great exactneſs with a good inſtrument. Then having meaſured the ſides with care and exactneſs, we have the angles and ſides of an irregular polygon given to find the area. If the bearings of the ſeveral ſides are deſired, they may in the following manner be made to ariſe from the calculation itſelf. Interpolate the polygon, at the prime angle, with an indefinitely ſhort ſide, being a meridian line, had by celeſtial obſervations, or the magnetical needle. Take the angles, which this ſide makes with the adjoining ſides of the polygon, and note them down with the reſt. This infiniteſſimal ſide is to be conſidered as the prime ſide, and may be expreſſed by O. Having obtained the angle of commutation for the ſecond ſide, inſtead of the deſignating letters A, B, introduce the initial letters of the cardinal points proper to that ſide; diſtinguiſhing thoſe that ſtand in the room of B by a daſh over the top. The angles of commutation will now become the points of compaſs, and expreſs the true bearing of each ſide.

EXAMPLE

EXAMPLE 1.

A. C.	S. B.	P.
69°. 43′ A. o A.	o o	o
125° 125 A. 55 B. N. 55 $\bar{C}$.	18 14.74	10.32 0.00 10.32
—13° $\bar{S}$. 42 W.	6 4.01	—4.46 5.86 1.40
22°∠ N. 64 $\bar{E}$.	12 10.78	5.27 6.67 11.94
40° $\bar{S}$. 24 W.	4.17 1.70	—3.81 8.13 4.32
134°. 17′ 110. 17 $\bar{S}$. 69. 43 W.	21.12 19.81	—7.32 —3.00 —10.32
NW. S E.	N E. S W.	
23.4986 13.8210 37.3196	71.9026 59.4300 131.3326 37.3196 94.0130 Area is 47.0065	

EXAMPLE 2.

A. C.	S. B.	P.
55°. 9 B. o B.	o o	o
140° B. 40 A. $\bar{N}$. 40 E.	10 6.43	7.66 100.00 107.66
84°∠ 124 $\bar{N}$. 56 $\bar{W}$.	4 3.32	2.24 109.90 112.14
24° S. 80 E.	9 8.86	—1.56 110.58 109.02
125° 205 S. 25 E.	8 3.38	—7.25 101.77 94.52
11° $\bar{N}$. 36 $\bar{W}$.	7 4.11	5.66 100.18 105.84
126°∠ S. 90 $\bar{W}$.	3 3.00	—0.00 105.84 105.84
90° 180 S. o E.	1 0.00	—1.00 104.84 103.84
124°.51′ 124 .51 S. 55.9 $\bar{W}$.	10.04 8.24	—5.75 98.09 92.34
	18.67 18.67	7.66 100.00

W. Area.

364.8680
411.7398
317.5200
808.2616

1902.3894

E. Area.

643.0000
979.7388
343.9826

1966.7214
1902.3894

64.3320

Area is

32.1660

Canaan, (Connecticut) March 20, 1792.

Remarks on Mr. Winthrop's paper on the duplication of the Cube in part 1st of this volume. By GEORGE BARON, *late Master of the Mathematical Academy at South Shields, in the County of Durham, in England.*

MR. Winthrop has attempted the duplication of the Cube, in a paper inſerted at page 25, part I. vol. 2, of the Memoirs of the American Academy of Arts and Sciences. This paper is entitled "Geometrical methods of finding any required ſeries of mean proportionals between given extremes." It conſiſts of four problems. In problem 1. is ſhewn the well known method of finding one mean proportional between two given extremes. Problem 2. is "To find two mean proportionals between two given extremes." On the truth of this problem the two remaining problems, together with Mr. Winthrop's duplication of the Cube, entirely depend. I ſhall therefore here, firſt deſcribe Mr. Winthrop's method of finding two mean proportionals between two given extremes: Secondly, ſhew that the demonſtration which he has attempted to give of that method is not true. And thirdly, I ſhall demonſtrate that that method is univerſally falſe. And hence it will follow, that Mr. Winthrop's duplication of the Cube is univerſally falſe.

Firſt then, I am to deſcribe Mr. Winthrop's method of finding two mean proportionals between two given extremes. The ſubſtance of it is as follows.

Let

Plate 1.

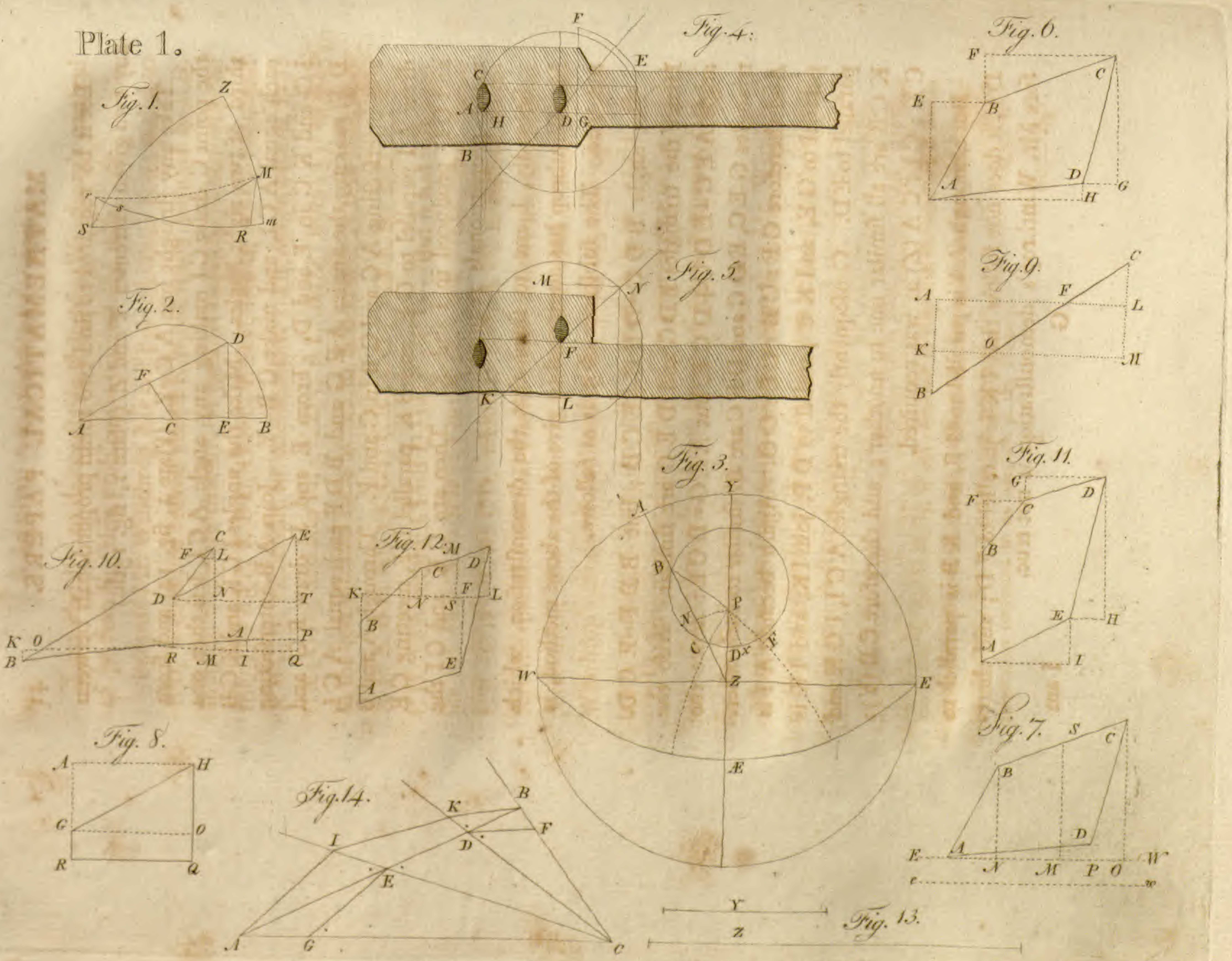


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10.
Fig. 11.
Fig. 12.
Fig. 13.
Fig. 14.

Let it be required to find two mean proportionals between any two given extremes Y and Z. (Plate 1, fig. 13th.)

Take any ſtraight line A C=Z, (Plate 1, fig. 14) and from the point C draw C I making any angle A C I, leſs than one third of two right angles. Make the angles I C K and K C B each equal A C I, and make C B=Y. Join A B interſecting I C and K C in E and D. From E and D draw E G and D F, making the angles A E G and B D F each equal A C I, and interſecting A C and C B in G and F. Through A and B draw A I parallel to G E, and B K parallel D F, meeting C E and C D produced in I and K. Then are C K and C I the mean proportionals required.

Secondly, I am to ſhew that the demonſtration, which Mr. Winthrop has attempted to give of the above method, is not true. The ſubſtance of it is as follows.

The angle B D C=D E C+E C D; but B D F=E C D. Hence the triangles F D C and D E C are ſimilar. Alſo the angle A E C=E D C+D C E, but A E G=D C E: hence the triangles G E C, E D C and D F C are all ſimilar to each other. And therefore C F : C D : C E : C G. Again becauſe A I is parallel to G E, and K B parallel to D F, join I K, and I K is parallel to E D. Conſequently the triangles A C I, I C K and K C B are all ſimilar one to another; and therefore C B (Y) : C K : C I : C A (Z) as was required.

But although A I is parallel to G E, and K B is parallel to D F, it does not follow that I K is parallel to E D; and therefore Mr. Winthrop's demonſtration is not true.

I am thirdly to demonſtrate that Mr. Winthrop's method of performing this problem is univerſally falſe.

Becauſe Mr. Winthrop has not proved that I K is parallel to E D, it does not follow that I K is not really parallel to E D. Imagine therefore that I K is parallel to E D. Then will the triangles A I E, K B D, G E C, E D C, D F C, A I C, I K C and K B C be all ſimilar to one another. Therefore I E : K D : : C E : C D; and alſo I E : K D : : A I : B D. But A I is to B D in the complicated ratio of A I to K B and of K B to B D, and A I : K B : : A C : K C : : $\overline{CE}^2 : \overline{CD}^2$; alſo K B : B D : : C E : C D. Therefore A I : B D : : $\overline{CE}^3 : \overline{CD}^3$. But it has juſt been proved that A I : B D : : I E : K D : : C E : C D; and hence $\overline{CE}^3 : \overline{CD}^3$: : C E : C D, which is abſurd. I K cannot therefore be parallel to E D; and conſequently this method of performing the problem is univerſally falſe. And as Mr. Winthrop's mode of duplicating the Cube depends upon the truth of this problem, it is alſo univerſally falſe. Q. E. D.

The ſame may be demonſtrated by a variety of other methods. For inſtance by the addition of ſines, tangents, &c. or by the logarithmic ſpiral.

I muſt at the ſame time acknowledge that Mr. Winthrop's miſtake on this ſubject was ſo natural, that I at firſt followed him in it. A ſecond inſpection convinced me of my miſtake.

HALLOWELL, in the DISTRICT of MAINE, June 2, 1798.

N. B. Soon after the paper, to which Mr. Baron's obſervations relate, was communicated to the Academy, it was examined by ſeveral of the members, ſkilled in mathematical ſcience, who were of opinion, that the author had not demonſtrated his theorem. But at the particular requeſt of the author the committee for publication conſented to its inſertion in the Memoirs.

Mr. JOSEPH POPE's defcription of an Orrery of his conftruction.

As the number of appearances, explained by an Orrery, depends upon the number and exactnefs of its motions, the following defcription of the performances of the Orrery completed by me in the year 1788, will fhew its utility.

On the large circle of this machine, reprefenting the ecliptic, are engraven the figns and degrees of the Zodiac, with the days and months of the year ; in the centre of which, is a brafs ball, reprefenting the SUN, turning on its axis, in $25\frac{1}{4}$ diurnal rotations of the earth ; its axis declines from the axis of the ecliptic circle, 8 degrees, and its north pole tends towards the 8th degree of Pifces.

The planets reprefented by ivory balls, are as near their relative diameters and diftances as the convenience of the machine will permit ; they revolve round the fun in their various eccentric and inclined orbits. Mercury, the neareft to the Sun, being the firft in order, with his axis perpendicular to the ecliptic, performs his motion round the Sun in $87\frac{23}{24}$ diurnal rotations of the earth, or in 87 days, 23 hours.

The next is Venus, fhe performs her annual courfe in 224 days 17 hours, of our time, and her diurnal motion, in 24 days 8 hours ; her axis declines 75 degrees from that of the ecliptic, keeping parallel to itfelf ; the North Pole tends towards the 20th degree of Aquarius.

The

The next to Venus is our Earth, half covered with a black cap, which is always in oppoſition to the Sun. She makes $365\frac{1}{4}$ diurnal rotations on her axis in the ſame time ſhe performs her annual revolution: her axis declines from that of the ecliptic, 23 degrees 29 minutes, preſerving its paralleliſm round the Sun; her north pole tends towards the firſt degree of Cancer. The Moon, accompanying the Earth, performs her periodical revolution in 27 days, 7 hours, 43 minutes, turning on her axis exactly once in the ſame time, and performing her ſynodical revolution, or from ſun to ſun, in 29 days, 12 hours, 45 minutes. On the circle repreſenting her orbit are marked the nodes and degrees of her north and ſouth latitudes, the plane of which forms an angle of 5 degrees with the plane of the ecliptic; the nodes have their back motions paſſing through all the ſigns and degrees in $18\frac{2}{3}$ years. There is another body, half covered with a black cap, which at all times ſhews its dark part; it turns on its axis, which declines from the axis of the ecliptic and keeps parallel to itſelf round the earth; it exhibits all the phenomena explained by the above moon.

Mars is without the earth's orbit, with his axis perpendicular to the ecliptic, performing his annual motion in $686\frac{23}{24}$ days, and diurnal in 24 hours, 40 minutes.

Jupiter is at a greater diſtance from the Sun than Mars, with his axis perpendicular to the ecliptic, completing his annual circuit in 11 years, and 314 days, 18 hours, and his diurnal motion in 9 hours, 56 minutes.

Saturn,

Saturn, the moſt diſtant from the ſun of all the planets in the machine, with his axis perpendicular to the ecliptic, performs his annual courſe in 29 years, 167 days, 1 hour.

The Satellites of Jupiter and Saturn, at their different diſtances, nearly in true time, revolve round their primaries; the one moſt remote from Jupiter revolves in its inclined orbit; the orbits of the other three are coincident with the plane of the ecliptic. Saturn's five ſatellites,* in their revolutions, keep in the plane of his ring, which forms an angle with the plane of the ecliptic of 30 degrees, and preſerves its parallelifm round the Sun..

There are two dial plates, one ſhewing the common, the other the ſidereal time; alſo ſeveral other pieces, which may be applied occaſionally, viz. a ſmall horizon circle, ſemicircle, ſolar ray, &c. The whole machine is put in motion by the turn of a ſingle winch.

JOSEPH POPE.

November 12, 1794.

* Mr. Pope's Orrery was conſtructed, and this account of it prepared, before Dr. Herſchel's diſcovery of the two additional ſatellites of Saturn was announced.

PHYSICAL PAPERS.

I. *Description of four remarkable Fishes, taken near the Piscataqua in New Hampshire.* *By* WILLIAM D. PECK, *Esq.* A.A.S.

THAT part of the Atlantic which washes the extensive sea coast of Massachusetts, affords a considerable number of Fishes, many of which are but little known; and very few have been systematically noticed. This is not surprising, when it is considered that our fishermen are very inattentive to any but such as are esteemed fit for food. Of these the number is comparatively small, nor are the specific characters of them as yet ascertained. Four Fishes of different genera will be the subject of this paper.

The first, (Plate II. fig. 1.) was brought me by a boy who called it a white eel. The head of this fish is naked and whitish; the vertex flatted, the upper and hinder edge of the orbits a little elevated. The nostrils are tubular, and situated near the extremity of the snout, which is obtuse.

The upper jaw is shorter than the lower, and furnished with a double row of small teeth; and a single row of larger, curved teeth, inserted in the margin of the palate. The lower jaw is without a beard; the front teeth in a tripple, and the lateral ones in a double row, all curving back.

The

The branchial membrane is expanded, naked, and ſupported by ſix bones.

The eyes, rather ſmall and black, have the iris ſomewhat ſilvery, and are a little ſunk in their orbits. The head is $1\frac{7}{8}$ inch in length.

The body is long, nearly round, ſlippery, and deſtitute of ſcales; diminiſhing gradually from the beginning of the anal fin, and ending obtuſely at the inſertion of the tail. The colour of the body is nearly that of the human ſkin, with ſcattered blotches of a pale ruſt-colour.

There is no lateral line. The anus is placed before the equilibrium of the fiſh.

The dorſal fin occupies the whole length of the back, beginning a little behind the region of the pectoral fin, and extending to the tail, with which it is connected by its membranes. It is ſupported by LXXVI ſimple rays, which do not perforate the margin of the fin.

The pectoral fin is ſmall, of a broad oval figure, inſerted a little behind the branchial aperture, and furniſhed with XIV ſoft, branched rays.

There are no ventral fins. The anal fin has XLIX rays, the three firſt of which are ſimple, the reſt branched. It extends to the tail, with which like the dorſal fin, it is united by its membranes. The laſt rays in both are a little removed from thoſe of the tail, ſo that they are eaſily diſtinguiſhed.

The

The caudal or tail fin is rounded and ſupported by XXII branched rays, and marked with numerous black dots.

From the above particulars, this fiſh appears to be a ſpecies of Ophidium or Snakefiſh, and approaches moſt nearly the Ophidium imberbe of Linnæus, which he ſays, is an inhabitant of the Baltic, and often found within the ſhells of oyſters.* He obſerves alſo that the dorſal fin has ten ſpots :* but the ſpecimen above deſcribed is above nineteen inches in length, and the back fin of an uniform colour. It may be called for the preſent *Ophidium (imberbe) maxillis imberbibus, cauda rotundata, pinnâ dorſi unicolore.* It was taken in a muddy creek in the river Piſcataqua, and is the only individual of this genus that I have met with.

Whether it is in fact a variety of the Ophidium imberbe of Linné, or a new ſpecies, time may diſcover. It is ſketched at fig. I.

Fig. II. (Plate II) repreſents a fiſh which was brought me in the month of Auguſt. The body of this fiſh is nearly ovate, compreſſed, and its breadth is equal to about one third of its length ; thickeſt in the middle ; gently convex, and becoming thinner to an edge, at the back and abdomen. The colour of the back is dark, eſpecially the head, which is nearly black and deſtitute of ſcales.

The head is compreſſed and declining from its union with the body to the noſe ; of the ſame thickeſs with the body ; and from the extremity of the upper lip, to the angle of the opening

* Fauna ſvecica edit. 2da. Stockholm, 1761, page 114.

opening of the gills is equal to ⅐th of the length of the fiſh. The mouth obliquely deſcending, backward, and of a middling ſize. The roſtrum obtuſe. The upper jaw a little ſhorter than the lower. The teeth very ſmall, cylindric, ſtrait, erect, equal, and cloſely ſet, in a ſingle row, in the margin of both mandibles. The tongue entire and rounded. The palate deſtitute of teeth. The noſtrils double ; nearer to the roſtrum than to the eyes ; the anterior foramen ſmall and round, the poſterior larger and vertically oblong. The eyes are lateral, nearly in the middle of the head, almoſt round, naked ; the iris ſilvery with the upper part blueiſh ; the pupil rather large and black. The covers of the gills, are formed of two laminæ, the exterior of which is ſmaller, ſemiovate, marked with obſcure furrows diſpoſed in a radiate form, and of a ſilver colour : the interior is larger, and contained within the ſegment of a circle, whoſe centre is near the pupil of the eye. There are no ſcales on theſe covers. The branchial membrane is in a great meaſure covered ; it contains ſix oſſicles, the firſt and ſecond much the ſhorteſt, and all of them much curved. The head and anterior part of the back as far as the beginning of the dorſal fin are without ſcales.

The back is arched, and becoming gradually thinner from the middle of the fiſh upward, and towards the root of the fin is marked on each ſide with a dotted line, compoſed of about twenty pores, placed in a ſingle row, beginning even with the fin, and extending parallel to it, a little more than half its length.

Mo. Bot. Garden,
1897.

The ſides are gently convex. The abdomen nearly of the ſame figure with the back and is a little more arching : the carina is bony, as in the herring tribe, but not ſerrated. The lateral line is curved ; and near the back but not quite parallel to it. The anus linear, and one third nearer the head than to the tail. The tail narrow and terminated by a deeply divided fin.

The ſcales are rather ſmall, imbricated, ſmooth, cloſe, flexible, and eaſily rubbed off ; of a bright pearl colour.

There is a ſmall horizontal ſpine, pointing forward, at the beginning of the dorſal fin ; another at the beginning of the anal fin : and a third, ariſing from the ſternum and pointing backward, a little before the anus.

The dorſal fin occupies almoſt the whole length of the back, and terminates at the narrowing of the tail. It contains XLV rays, the four firſt ſimple, the reſt branched, the fifth and ſixth longeſt ; thence gradually ſhorter to the middle of the fin, from which they retain nearly the ſame length. The pectoral fins are lance ſhaped, about a quarter part as long as the fiſh, and furniſhed with XXI ſoft rays, the lower ones very ſhort. There are no ventral fins. The anal fin is of the ſame form with the dorſal, but ſmaller ; extends as far back as that does, and is ſupported by XLII rays. The tail fin forked and acute, a little ſhorter than the pectoral and has XXI rays.

The whole length of the ſpecimen from which the figure

was taken, was $9\frac{5}{8}$ inches, its breadth $3\frac{3}{10}$ inches, and its thickneſs $1\frac{1}{8}$ inch, in the thickeſt part.

This fiſh is furniſhed with two ſtomachs, one of which is ſituated near the throat and is nearly round, muſcular, and rough on the inſide ; the other is in the abdomen. It becomes putreſcent ſo ſoon after being taken out of the water, that the internal economy could not ſatisfactorily be farther inveſtigated.

In the principal particulars of its generic character it accords with the Stromateus of Linné ; its ſpecific character may be taken from the ſpines with which it is armed : hence it may be defined Stromateus (triacanthus) ſpinulâ antrorſum decumbente ante pinnam dorſalem et analem, aliâque poſticé ſpectante ante anum. Linné in Syſt. Nat. Vol. I. p. 432 mentions two ſpecies, the Stromateus (Fiatola) ſubfaſciatus, and St. (Paru) unicolor, and to the latter he adds a ſynonym from Sloane's Nat. Hiſt. of Jamaica.* The ſpecimen above deſcribed differs from the Fiatola in not being at all ſtriped, and from the Paru it differs exceedingly in the form of the dorſal and anal fins, as well as in the ſpines, if Sloane's figure is accurate.

This genus appears to have been named by Artedi from Στρωματεὺς, Pulvinar, as the gentle convexity of the ſides gives ſomewhat the appearance of a cuſhion.

I have given it a trivial name and defined it as a new ſpecies ; and have been induced to this by being unable ſatisfactorily

* Sloane's Nat. Hiſt. of Jamaica, Vol. II. plate 250, fig. 4. Pampus.

torily to apply to it either of the Linnean definitions. As truth is the great object in inquiries of this kind, if I have fallen into an error, I ſhall think myſelf indebted to any experienced naturaliſt who ſhall ſet me right.

In the ſummer months, the fiſhermen ſometimes find a ſingle fiſh of this kind in their wears; but ſince writing the above, a fiſherman brought me four, which he took up with his hands from a crowded ſchull, that he believed occupied three acres in extent. They were taken on the New Hampſhire coaſt, about a league from the mouth of the Piſcataqua. There is no popular name for it. It is probably a migratory fiſh.

Fig. III. is the figure of a fiſh which is taken on the haddock grounds, principally in the months of March and April.

Its body is enſiform, ſubcylindric, diminiſhing gradually toward the tail; ſlippery, covered with a copious lubricating humour and a very tenacious ſkin. The colour approaches umber, eſpecially on the back; on the abdomen pale, and in ſome ſpecimens whitiſh.

From the middle line upwards, through the whole length, it is marked with darker ſpots, arranged in a triple ſeries, ſo as to appear in a manner chequered.

The head declining, broader than the body, and ſmooth; equal to about ⅛th part of the length of the fiſh. The mouth large and nearly horizontal. The ſnout a little acuminated. The upper jaw longeſt. The lips fleſhy and thick, the upper one a little folded back; the lower one looſe, and pendant at the ſides. There are no cirri.

The

The cheeks muſcular and protuberant. Teeth conical in both jaws.

The upper front teeth larger than the lower, and placed in a double row ; the lower front teeth alſo in a double row ; the lateral ones, both above and below, ſimple, and extend as far back in the jaws as the angle of the mouth. The upper ones are about 18 in number, on each ſide ; the lower ones about 12 ; they are all bent a little back and in a great meaſure concealed by looſe gums. There are no teeth in the palate. The noſtrils are tubular, and ſituated about half way between the eyes and the extremity of the roſtrum.

The eyes are placed high, are rather oval than round ; rather ſmall, and naked. The Iris golden. The branchial membrane contains ſix ſtrong rays, and is but little covered.

The back is nearly ſtraight ; the abdomen tumid : lateral line ſmall and obſcure. The anus much nearer the head than the tail, ſo that from the throat to the anus is ſcarcely $\frac{1}{4}$th part the length of the fiſh. The tail from the anus to the end, contains above $\frac{3}{5}$ths of the length of the fiſh, and tapers gradually to its extremity, ending in a point. The ſcales are ſmall, nearly oval, ſeparate, adhering by their whole under ſurface, and a little ſunk beneath the ſuperficies of the ſkin. They are repreſented by dots in the figure.

The dorſal fin begins a little back of the head, extends the whole length of the back, is united with the tail fin, and at its point joins the anal fin. It contains CXLVI rays, XVIII of which,

which, from the 99th to the 116th incluſive are very ſhort, curved backward, and pointed ; the reſt are ſoft and branched. The pectoral fins are rounded and contain XX ſtrong branched rays. The ventral fins are placed under the throat and contain III rays. The anal fin extends from the anus to the extremity of the tail where it is united with the dorſal, and contains CXXIII branched rays. The caudal fin is ſo united with the dorſal and anal that it is difficult to ſeparate them ; it is therefore divided equally between them. The laſt rays are ſo minute that they cannot be enumerated without removing the ſkin.

In the internal economy, as well as in ſeveral external particulars, it reſembles the catfiſh. The ovarium is ſingle ; and like other fiſhes which reſide at the bottom, it has no air bladder.

It feeds principally on echini and aſteriæ of ſeveral ſpecies. To collect its food, it is neceſſary that it ſhould frequent rocky places, and to this it muſt be owing, that in the larger individuals, the ventral fins are entirely obliterated, except two ſmall cicatrices ; ſo that at firſt view they appear to be a ſpecies of Anarhicas.* It is therefore from the younger fiſh only that the claſſical character can be determined. From the reſemblance above mentioned it has probably obtained the name

* Lupus marinus of authors. Anarhicas Lupus of Linné, called here catfiſh, and wolf fiſh, or catfiſh in Dr. Cullen's catalogue of the Mater. medic.

name of Wolf, by which it is known to our fiſhermen. It is ſometimes called Conger Eel. In the conſiſtence of the muſcles it is like the eel, and deprived of its head and ſkin, it is ſometimes ſold as ſuch ; but it is preferable to the eel, as it feeds on living food ; whereas the eel feeds on carcaſſes. The largeſt I have ſeen was 31 inches in length.

This fiſh is a ſpecies of Blennius : it appears to differ from all the Linnean Blennii, and uncertain whether it has ever been deſcribed, I ſhall take its trivial name from the form of its body, and call it Blennius (anguillaris) pinnis dorſali, anali, caudalique unitis ; dorſali prope caudam radiis octodecim abbreviatis ſpinoſis.

The fiſh repreſented at fig. IV, is of the carp kind and is the Cyprinus (Catoſtomus) pinnâ ani radiis octo, labio imo carunculâ bilobatâ papilloſa, caudâ bifidâ ; firſt deſcribed and figured by Dr. John Reinhold Forſter in the 63d Vol. of Tranſactions of the Royal Society. His figure, compared with this, will be found to differ in the form of the head, although they both have the ſame ſpecific marks.

Dr. Forſter obſerves that, in his ſpecimen, " the head was full of elevations and tubercles ; that he could not determine the colour of the iris of the eye ; that the body was compreſſed or flat." It ſeems probable from theſe circumſtances, that his ſpecimen had been expoſed to the air and in ſome meaſure dried before he received it. The delineation here given was made with tolerable accuracy from a ſpecimen newly taken.

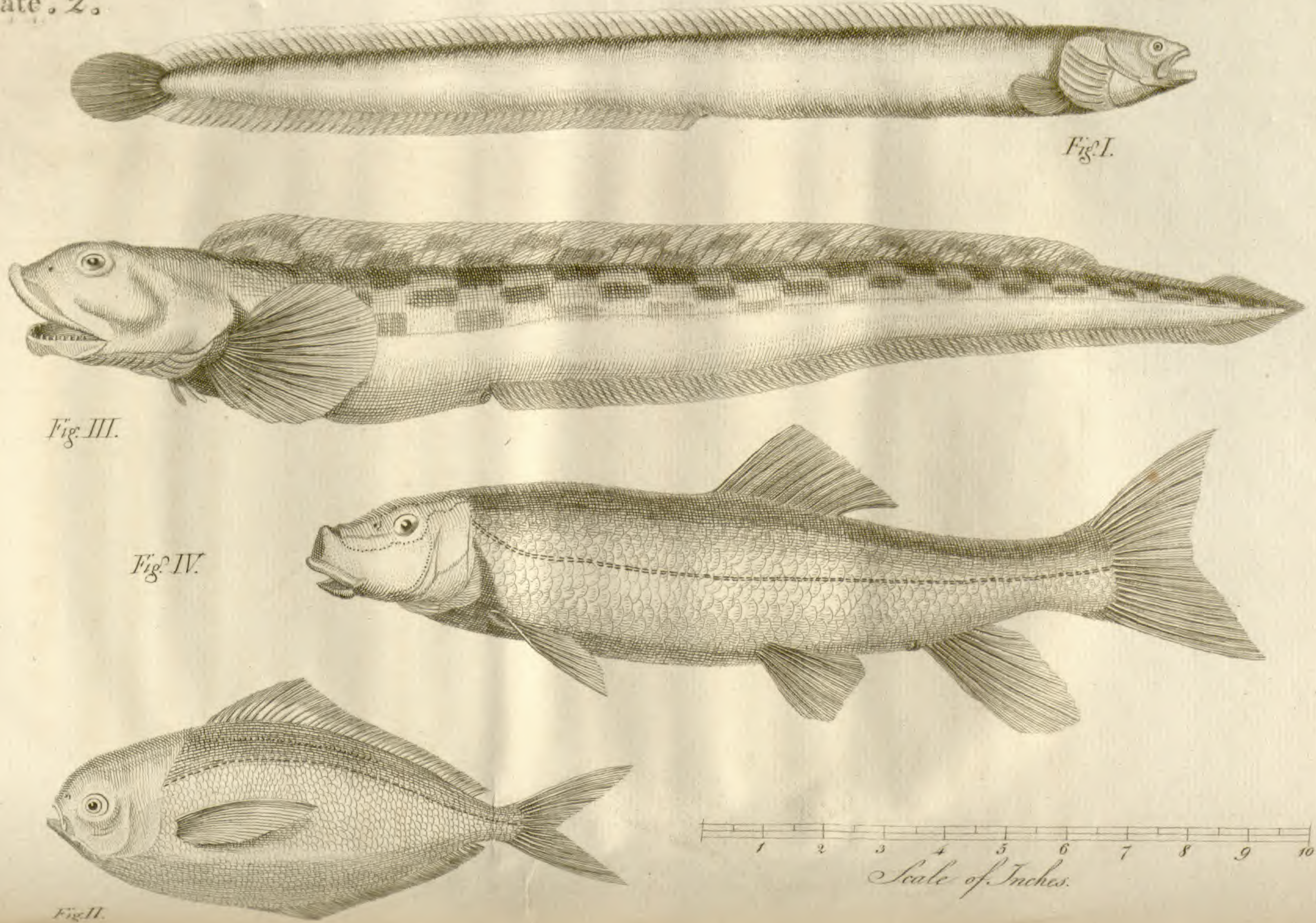
The

The head had no remarkable elevations except that over the noſe and the ſutures expreſſed by dotted lines in the figure. It is one of the roundeſt of its genus. The head is of the ſame breadth with the body, " gradually decreaſing toward the noſe. The mouth is quite under the head ; when ſhut, it is ſemilunar ; when open, round ; not far from the extremity of the ſnout and included in ſmall round lips. To the under lip is fixed a bilobate, beardlike, papilloſe caruncle. There are no teeth." The eyes are rather large, the iris of a a pale, golden colour. There are III rays in the branchial membrane. " Over each eye is a longitudinal ſuture." There is no tranſverſe ſuture between the noſtrils. " On the covers of the gills are two, one on each ſide, beginning near the lobes of the caruncle of the under lip and going up arched toward the eye. Near the extremity of the ſnout begins on each ſide a longitudinal one, paſſes round the eye and mounts in a curvature behind it, then it goes on" a little waving " to the end of the head, where it again gets downwards and joins the lateral line. Where the head joins the body the two ſutures are connected by a tranſverſe one, which, as it were, ſeparates the head from the body. The lateral line at firſt deſcends, then runs on ſtraight, rather nearer the back than the belly, to the beginning of the tail."

The top of the head, and back are of an umber colour, becoming paler on the ſides ; the body underneath is whitiſh with a caſt of fawn colour, and according as it is placed in the ſun, reflects a golden luſtre.

" The

Plate. 2.



" The ſcales are ſmall near the head and back, increaſing in ſize toward the middle and tail, cloſe to which they are again ſmaller. The dorſal fin is ſomewhat behind the equilibrium of the fiſh, rhomboidal and conſiſting of XII ſtrong branched rays."*

Pectoral fins of a broad lance ſhaped figure, placed near the covers of the gills, and contain XVII rays. The ventral fins have IX rays. The anal fin is rather large and ſtrong, ſupported by VIII rays, the firſt of which is ſimple, the reſt branched, the laſt divided at its baſe, and has the appearance of two rays. " The tail ſomewhat forked or concave," and contains XIX rays. The pectoral, ventral, and anal fins are tinged with yellow.

Dr. Forſter's ſpecimen was from Hudſon's bay, and he mentions " two varieties, both whitiſh ; but one diſtinguiſhed by a mixture of a beautiful red." This which is found in our waters is probably a third variety. The moſt remarkable particular in its internal ſtructure is the form of the air bladder, which at about ⅓d part from its anterior extremity is contracted into a ſmall neck, in ſuch a manner that there appear to be two bladders ; the anterior nearly round, the poſterior oblong and ſomewhat conical.

It is called Sucker in the neighbourhood of Boſton, and in the Diſtrict of Maine it is improperly named Barbel.

KITTERY, 19*th Sept.* 1794.

II. *On*

*For theſe quotations, ſee Phil. Tranſact. of Royal Soc. of Lond. Vol. 63. part I. page 155, and for the figure, ſee plate 6, page 157, ejuſdem.

II. *On Meteorological Obſervations and Bills of Mortality, in a letter from* EDWARD A. HOLYOKE, M.D. A.A.S. *to the late* EDWARD WIGGLESWORTH, D.D. A.A.S.

Salem, Feb. 22d, 1790.

DEAR SIR,

I AM much obliged to you for a ſight of thoſe papers, you forwarded to me by Mr. Prince : I think your method of communicating the reſults, only, of your meteorological obſervations, much to be perferred to the groſs bill, for though, to condenſe them in this manner, be a work of much labour, yet it occaſions ſuch papers to be much more attended to, than they otherwiſe would be, and of courſe much more uſeful ; though I think it might be uſeful too, to file the obſervations, at large, with the ſecretary, becauſe there may be certain inferences of importance drawn from theſe, which cannot be from thoſe, ſuch as, E. Gr. the effect the winds have upon the mercury in both barometer and thermometer, &c.

I could not help attending, particularly, to the article of winds, by which I find all the American obſervations, I have met with, on that head confirmed, and that yours agree with what I have advanced in a paper I preſented to the Academy on the comparative cold and heat of Europe and America, viz.

 that

that westerly winds are by much the most prevalent; for the two years contained in your paper I find the westerly winds are to the easterly as 673 to 258.

I was glad to find by your communication on the bills of mortality, that so many gentlemen have attended to this matter; and hope the stock of these bills will be much enlarged, as it is only from a large number, and those continued for a course of years, that general conclusions can be deduced with any good degree of certainty. And I could wish that when gentlemen are at the trouble of forming bills of this kind, that they would be as particular as possible: I think much information might be obtained from a *monthly* bill, which should likewise particularize the *diseases* of which each person died in each month, and the *age* of the deceased: this would inform us, not only which month was most fatal to our species; but also what kind of diseases were most prevalent in each month, and to what ages the fatality was chiefly confined; and these are all objects of importance.

Upon the bill of ages which you have collected, I would observe, that the 1st, the 5th, and 6th periods are the largest, and that the 3d is the least, in proportion to the numbers living; which facts may, I think, be accounted for thus; Infancy is an almost continued state of sickness, and the human body, not having yet attained any considerable degree of strength and vigour, many at this period must of course sink under their various maladies: but between 10 and 15 (the 3d period)

when

when man has ſurvived the danger of infancy, and the body hath acquired ſome degree of firmneſs, but not its full growth, he is then but little liable to diſeaſes, eſpecially ſuch as ariſe from obſtruction, as the veſſels are now ſoft and pliant, and at the ſame time enlarging every day, in diameter, ſo that if obſtructions ſhould be formed, the natural and rapid growth hath a direct tendency to prevent any mortal effects from this cauſe. But between the ages of 20 and 30 (the 5th and 6th periods) the mortality is greatly increaſed; which occaſioned me no ſmall ſurpriſe when I firſt attended to this circumſtance, 7 or 8 years ago, when I firſt began to keep an account of deaths; but which I believe muſt be accounted for in this way. It was obſerved by Hippocrates, and the obſervation has been confirmed by almoſt every phyſician ſince, who has treated of the ſubject, that pulmonary phthiſis is by far the moſt incident to perſons between 18 and 35 years old: now this diſeaſe has of late become much more frequent, both here and in Europe, than formerly, and makes up, I believe, at leaſt a 10th, perhaps a 6th of our whole bill of mortality; if then we take 489, i. e. about one 10th of the deaths in your bill, and diſtribute that number into the years which Hippocrates and common obſervation tell us are moſt obnoxious to phthiſis, we ſhall find it will amply account for the increaſe of deaths in theſe periods; for we find that from 20 to 35 the deaths amount to 645, from which, if we deduct 489 for conſumptive caſes, we have left but 156 for the whole mortality of theſe 15 years, from other cauſes; to which we muſt add

that

that perſons, at this age, are as liable to fevers, as perhaps at any other, and that their numbers are greater than at any ſubſequent period: ſo that with the exception of phthiſis this period is perhaps the moſt favourable to human life.

Si quid noviſti rectius iſtis, candidus imperti,
Si non, his utere mecum.

I am with eſteem, Sir, your very humble ſervant,

E. A. HOLYOKE.

Rev. Profeſſor Wiggleſworth, D. D.

Synopſis

Synopsis of several Bills of Mortality, by Rev. JOSEPH M'KEAN, A.A.S. *President of Bowdoin College.*

Place and time of observation.	No. of dths.	Under 1 y.	Bet. 1 & 5	5 & 10	10 & 20	20 & 30	30 & 40	40 & 50	50 & 60	60 & 70	70 & 80	80 & 90	90 & 100	Ab. 100
Roxbury, 1st parish, from 1783 to the end of 1793. 11 years.	245	41	47	3	14	30	25	13	15	20	23	13	1	0
Marblehead, 2d parish, 1787 to 1792. 6 years.	337	75	75	16	13	28	30	27	22	24	13	12	2	0
Stow, 1775 to 1796. 22 years.	266	46	57	27	23	21	11	11	13	11	27	16	3	0
Brimfield, 1775 to 1789. except 1785. 14 years.	212	42	33	15	17	23	18	15	9	8	12	17	3	0
Westfield, 1782 to 1791. 10 years.	234	46	30	13	20	24	17	11	12	20	24	12	5	0
East Kingston, 1740 to 1771. 32 years.	283	62	62	27	24	26	19	22	16	9	11	5	0	0
Barnstable, East precinct, 1786 to 1795, except 1793. 9 years.	168	32	21	2	8	14	9	11	15	16	25	13	2	0
Hamilton, 1772 to 1796. 25 years.	294	63	29	5	23	25	16	22	20	30	23	30	6	2
Exeter, 1784 to 1788. 5 years.	126	18	14	5	9	17	10	10	6	11	12	12	2	0
Salem, 1783 and 1784, 304 deaths, ages unknown 13, reckon only	291	71	76	16	10	32	21	20	11	11	15	8	0	0
Edgartown, 1761 to 1791. 31 years.	367	97	50	3	16	46	17	27	14	19	16 / 20	19 / 10	4 cert. / 3 unc.	
Beverly, 1st parish, 1785 to 1797. 13 years.	589	139	112	29	23	59	56	31	31	39	33	32	5	0
Total,	3412	732	606	161	200	345	249	220	184	218	254	205	36	2

CONTINUED.

CONTINUED.

Place and time of observation.	No. of dths.	und. 1 year.	bet. 1 & 5	5 & 10	10 & 20	20 & 30	30 & 40	40 & 50	50 & 60	60 & 70	70 & 80	80 & 90	90 & 100	Ab. 100
Ipswich, 1st and S. parish, 1786, 7,	85	15	8	3	5	10	7	6	3	5	14	8	1	0
Salisbury, 1786 to 1788. 3 years.	77	11	8	6	6	6	2	8	2	8	11	8	1	0
Montague, 1786 to 1791. 6 years.	59	15	10	0	2	5	8	6	1	3	4	4	1	0
Northborough, 1786 to 1792. 7 years.	52	11	3	2	1	5	5	5	2	1	8	6	3	0
Hanover, 1786 to 1789. 4 years.	51	4	6	0	4	6	6	4	2	1	4	12	2	0
Gloucester, 1786.	42	3	5	3	3	8	4	5	3	2	4	2	0	0
Brookfield, 3d parish, 1786 to 1789. 4 years.	41	6	13	1	2	4	0	3	3	3	2	2	2	0
Cambridge, 3d parish, 1786 to 1789. 4 years.	29	5	5	0	4	2	4	4	0	0	2	1	2	0
Cambridge, Dr. Rand's observations, 1786 to 1788. 3 years.	26	1	7	2	1	1	3	1	1	4	2	3	0	0
Fryburg, 1786 to 1790. 5 years.	25	8	4	3	1	0	3	1	2	0	3	0	0	0
Wenham, 1786 and 1787.	21	1	4	2	0	0	2	1	0	3	5	3	0	0
Wilmington, 1786 and 1787.	19	2	2	1	1	2	2	0	1	3	2	2	0	0
Northampton, 1786.	19	4	2	0	1	3	1	1	1	2	2	2	0	0
Newbury, 2d parish, 1786 and 1787.	13	4	1	0	2	4	1	1	0	0	0	0	0	0
Reading, 1st parish, 1786.	8	2	0	0	0	1	1	0	2	1	1	0	0	0
Weymouth, S. parish, 1786.	8	3	0	0	0	0	1	1	1	0	2	0	0	0
West Hampton, 1786.	4	1	2	0	0	1	0	0	0	0	0	0	0	0
	579	96	80	23	33	58	50	47	24	36	67	53	12	0
Brought over,	3412	732	606	161	200	345	249	220	184	218	254	205	36	2
Total,	3991	828	686	184	233	403	299	267	208	254	321	258	48	2

CONTINUED.

CONTINUED.

The Bills from Hampton, Dover, Waltham, and Newton, give the number of deaths under 2 years, and between 2 and 5.

Place and time of obſervation.	No. of dths	und. 2 y'rs.	bet. 2 & 5	5 & 10	10 & 20	20 & 30	30 & 40	40 & 50	50 & 60	60 & 70	70 & 80	80 & 90	90 & 100	ab. 100
Hampton, 1735 to 1763.	624	166	65	53	62	50	35	23	23	43	59	30	15	0
From 1767 to Oct. 31, 1791.	260	58	14	10	11	27	8	15	13	19	41	36	8	0
Dover, 1767 to Sept. 1786.	377	93	29	21	18	24	24	27	19	37	48	31	5	1
Waltham, 1767 to 1788.	244	62	20	13	19	18	18	17	13	13	25	22	4	0
Newton, eaſt part, 1782 to 1791. 10 years.	129	29	4	7	5	12	8	13	9	8	16	14	4	0
Total,	1634	408	132	104	115	131	93	95	77	120	189	133	36	1

The Bills from Falmouth, W. Springfield, Hatfield, Aſhburnham, and one from Marblehead, give in one number the deaths under 5 years of age.

Place and time of obſervation.	No. of dths.	und. 5 y'rs.	bet. 5 & 10	0 & 20	20 & 30	30 & 40	40 & 50	50 & 60	60 & 70	70 & 80	80 & 90	90 & 100	Ab. 100
Falmouth, 1ſt pariſh, from 1769 to 1783. 15 years.	340	148	15	17	42	39	19	19	22	14	4	1	0
W. Spiingfield, 1770 to 1785. * 12 of theſe died in the army.	*209	98	13	10	19	9	9	3	14	21	11	2	0
Hatfield, from 4th March, 1772, to 4th March, 1792.	201	77	17	13	11	9	5	12	17	20	16	4	0
Aſhburnham, from 1769 to 1786. † 8 of theſc died in the army.	†136	85	2	5	20	5	1	1	3	8	5	1	0
Marblehead, 2d pariſh, 1786.	65	38	2	4	3	3	5	4	3	1	2	0	0
Total,	951	446	49	49	95	65	39	39	59	64	38	8	0

The

The whole number of deaths on the preceding bills is 6576, which happened at the following periods of life.

Under 5 years of age,	2500	Living at birth,	6576
Between 5 and 10	337	at 5 years,	4076
10 and 20	397	10	3739
20 and 30	629	20	3342
30 and 40	457	30	2713
40 and 50	401	40	2256
50 and 60	324	50	1855
60 and 70	433	60	1531
70 and 80	574	70	1098
80 and 90	429	80	524
90 and 100	92	90	95
Above 100	3	100	3

Stillborn infants, and deaths abroad, have been rejected, when they could be diſtinguiſhed. In the 828 deaths, which are ſaid to have happened in the firſt year of life, ſome ſtill-born are included ; but it is thought the number is not conſiderable. In the bills from Marblehead, about 12 or 15 deaths are ſuppoſed to have happened abroad, which could not be diſtinguiſhed. In the obſervations of ſeveral years at Edgartown, which were communicated in one bill to the Academy, the ages of thoſe who were upwards of 70, are not particularly noted. It is ſaid 39 were 70 years of age and upwards. The diſtribution of theſe to the following periods was made in the uſual proportion ; but marked as uncertain. This is the only inſtance in which any thing has been done

 by

by conjecture. All the other ages in the Synopsis are agreeable to the bills. The laws, by which the waste of human life is governed, are to be learned from facts, not hypothesis.

Deductions from select Bills of Mortality, by Rev. JOSEPH M'KEAN, A.A.S. *President of Bowdoin College.*

THE following tables were formed from observations made in Hatfield, from March, 1772, to March, 1792; in Stow, from Jan. 1775, to Jan. 1797; in the East precinct of Barnstable, from Jan. 1786, to Jan. 1796, except 1793; in Hamilton, from Jan. 1772, to Jan. 1797; and in the first parish of Beverly, from Jan. 1785, to Jan. 1799.

Age.	Hatfield.		Stow.		Barnstable E.P.		Hamilton.		Beverly, 1st parish.	
years	No. on the bills	Ann'l decr't	No. on the bills	Ann'l decr't	No. on the bills	Ann'l decr't	No. on the bills	Ann'l decr't	No. on the bills.	Annual decrement.
0	201	45	266	46	168	32	294	63	634	152
1	156	16	220	26	136	8	231	13	482	64
2	140	7	194	14	128	6	218	7	418	30
3	133	5	180	10	122	4	211	7	388	12
4	128	4	170	7	118	3	204	2	376	13
5	124	4	163	7	115	1	202	1	363	12
6	120	3	156	6	114	0	201	1	351	6
7	117	4	150	6	114	0	200	3	345	2
8	113	3	144	5	114	1	197	0	343	6
9	110	3	139	3	113	0	197	0	337	4
10	107	2	136	2	113	0	197	3	333	2
11	105	1	134	2	113	0	194	0	331	1
12	104	1	132	2	113	1	194	4	330	1
13	103	1	130	2	112	0	190	2	329	2
14	102	1	128	2	112	1	188	1	327	1

Age.	Hatfield.		Stow.		Barnstable, E. P.		Hamilton.		Beverly, 1st parish.	
years.	No. on the bills.	decrement.	No. on the bills.	decrement.	No. on the bills.	decrement.	No on the bills.	decrement.	No on the bills.	decrement.
15	101	1	126	2	111	1	187	4	326	2
16	100	1	124	2	110	1	183	2	324	2
17	99	2	122	3	109	2	181	5	322	6
18	97	1	119	3	107	1	176	2	316	2
19	96	2	116	3	106	1	174	0	314	4
20	94	1	113	2	105	1	174	4	310	4
21	93	1	111	2	104	1	170	0	306	3
22	92	2	109	2	103	2	170	1	303	4
23	90	1	107	2	101	1	169	2	299	8
24	89	1	105	2	100	2	167	5	291	8
25	88	1	103	2	98	1	162	2	283	7
26	87	1	101	2	97	1	160	2	276	6
27	86	1	99	2	96	1	158	6	270	6
28	85	1	97	2	95	2	152	2	264	8
29	84	1	95	3	93	2	150	1	256	11
30	83	2	92	1	91	1	149	2	245	8
31	81	1	91	1	90	1	147	1	237	6
32	80	1	90	1	89	1	146	2	231	5
33	79	1	89	1	88	1	144	1	226	2
34	78	2	88	1	87	1	143	1	224	7
35	76	0	87	1	86	0	142	3	217	4
36	76	0	86	1	86	1	139	2	213	4
37	76	1	85	2	85	1	137	1	209	9
38	75	1	83	1	84	1	136	2	200	8
39	74	0	82	1	83	1	134	1	192	5
40	74	1	81	1	82	1	133	2	187	5
41	73	1	80	1	81	2	131	0	182	5
42	72	1	79	1	79	1	131	2	177	2
43	71	0	78	1	78	1	129	1	175	2
44	71	0	77	1	77	0	128	2	173	0
45	71	0	76	1	77	0	126	6	173	1
46	71	0	75	1	77	1	120	1	172	0
47	71	1	74	2	76	2	119	3	172	7
48	70	0	72	1	74	2	116	3	165	5
49	70	1	71	1	72	1	113	2	160	7
50	69	2	70	1	71	1	111	5	153	3
51	67	2	69	2	70	2	106	2	150	4
52	65	1	67	1	68	1	104	2	146	0
53	64	2	66	1	67	2	102	1	146	4
54	62	1	65	2	65	1	101	0	142	7
55	61	1	63	1	64	2	101	3	135	3
56	60	0	62	1	62	1	98	3	132	3
57	60	1	61	1	61	2	95	0	129	4
58	59	1	60	2	59	1	95	2	125	4
59	58	1	58	1	58	2	93	2	121	1
60	57	1	57	1	56	2	91	7	120	3
61	56	1	56	1	54	2	84	1	117	2
62	55	2	55	1	52	2	83	1	115	4
63	53	2	54	1	50	2	82	7	111	3
64	51	2	53	2	48	2	75	2	108	7
65	49	2	51	1	46	2	73	2	101	2
66	47	2	50	1	44	1	71	1	99	5
67	45	2	49	1	43	1	70	4	94	4
68	44	1	48	1	42	1	66	4	90	8
69	42	2	47	1	41	1	62	1	82	4

Age.	Hatfield.		Stow.		Barnſtable, E. P.		Hamilton.		Beverly, 1ſt pariſh.	
years.	No. on the bills.	decrement.	No. on the bills.	decrement.	No. on the bills.	decrement.	No. on the bills.	decrement.	No. on the bills.	decrement.
70	40	2	46	2	40	3	61	2	78	2
71	38	3	44	2	37	3	59	1	76	3
72	35	2	42	3	34	4	58	4	73	6
73	33	3	39	3	30	4	54	1	67	4
74	30	2	36	3	26	3	53	3	63	2
75	28	2	33	2	23	2	50	3	61	4
76	26	1	31	3	21	1	47	3	57	1
77	25	1	28	3	20	2	44	1	56	3
78	24	2	25	3	18	2	43	5	53	4
79	22	2	22	3	16	1	38	0	49	7
80	20	3	19	3	15	2	38	10	42	7
81	17	3	16	3	13	2	28	1	35	7
82	14	2	13	2	11	1	27	3	28	4
83	12	2	11	2	10	1	24	2	24	1
84	10	1	9	1	9	1	22	6	23	2
85	9	1	8	1	8	1	16	3	21	4
86	8	1	7	1	7	1	13	3	17	0
87	7	1	6	1	6	2	10	0	17	1
88	6	1	5	1	4	1	10	2	16	5
89	5	1	4	1	3	1	8	0	11	5
90	4	1	3	1	2	0	8	3	6	0
91	3	1	2	0	2	1	5	0	6	0
92	2	0	2	1	1	0	5	1	6	2
93	2	1	1	1	1	0	4	0	4	2
94	1	1	0	–	1	0	4	0	2	0
95	0	–	–	–	1	1	4	0	2	1
96	–	–	–	–	0	–	4	1	1	0
97	–	–	–	–	–	–	3	0	1	1
98	–	–	–	–	–	–	3	1	0	–
99	–	–	–	–	–	–	2	0	–	–
100	–	–	–	–	–	–	2	0	–	–
101	–	–	–	–	–	–	2	1	–	–
102	–	–	–	–	–	–	1	1	–	–
	6281		7338		6462		10827		17388	
	100		133		84		147		317	
20	6181	22	7205	9	6378	25	10680	14	17071	
	309		133		708		427		1219	

From the whole number of perſons in each of the preceding tables, half the number that ſtands againſt 0 years is ſubtracted, becauſe they do not all come into life at once, and the ſeveral remainders, being divided by the number of years, in which the obſervations were reſpectively made, would give the number of perſons living in the ſeveral places of obſervation, if the births and deaths were equal.

The

The results are as follow,		The true numbers are,
Hatfield, -	309	- - - 703
Stow, -	327	- - - 830 mean.
Barnstable, E. P.	708	- - - 1365
Hamilton, -	427	- - about 900
Beverly, 1st parish,	1219	- - - 2561
Total,	2990	6359

The true number exceeds the number deduced from the tables, in nearly the same proportion that the births exceed the deaths.

The number of deaths on these bills is 1563, and the births in the same places, and same periods of time, were about 3375.

As 1563 : 3375 : : 2990 : 6456, differing but 97 from the true number, which in a calculation of this kind is not great, as the data cannot be perfectly accurate.

The mean annual number of deaths in the preceding places of observation is nearly 98, and the births nearly 213; the natural increase therefore is 115. Now, if 2990, the number of inhabitants deduced from the tables, were the real stock, this rate of increase would be sufficient to double the number in a little more than 18 years and one third. But as the real stock of inhabitants to be doubled by this increase is 6359, the period of duplication is 38 years and 7 tenths. It hence appears that the increase of population in the old towns in

New

New England is not ſo rapid as has been ſuppoſed. But the rates, at which even old towns are increaſing, are very different; as will appear from the following table, in which the times of obſervation, the number of inhabitants, the annual deaths, births, increaſe, and periods of duplication are exhibited together.

	Time of obſ.	No. inhab.	Deaths.	Births.	Increaſe.	Period of duplication.
Nantucket,	8 years	4620	63.62	175.	111.38	29.1 years.
Northborough,	$12\frac{2}{3}$	550	6.55	19.58	13.03	29 6
Stow,	22	830	12.13	28.63	16.50	35.2
Beverly, 1ſt pariſh,	14	2561	45.28	95.	49.72	36.
Barnſtable, E. P.	9	1365	18.66	44.44	25.78	37.
Shrewſbury,	20	963	12.15	26.75	14.60	46.
Hatfield,	20	703	10.05	20.15	10.10	48.6
Hamilton,	25	900	11.76	24.48	12.72	49.3
Newton,	10	1360	19.	38.20	19.20	49.5
		13852	199.20	472.23	273.03	

The whole number of inhabitants in theſe nine places is 13852, their mean annual increaſe is 273, and their period of duplication is $35\frac{1}{2}$ years.

Account of a Water Spout, in Watuppa Pond, at Freetown, in a Letter from NEHEMIAH BENNETT, *Eſquire, to* JOHN DAVIS, *Eſquire.*

Middleborough, Oct. 5, 1798.

DEAR SIR,

I HERE give you a deſcription of the remarkable Water Spout, which took place in Freetown, in the County of Briſtol, in a Pond called the *North Watuppa Pond.* The Pond is

is about four miles in length, from north to fouth, and from half a mile to a mile in width from eaft to weft. This phenomenon, which was feen at the diftance of eight or ten miles, took place in the month of Auguft, 1797. The day was clear and calm, and the pond very fmooth, previous to its beginning. Its firft appearance was about two of the clock in the afternoon. A roughnefs of the water was noticed near the eaft fhore of the pond, and very foon the water began to rife in form of a pyramid or cone, to appearance about forty feet in height ; thence it arofe perpendicularly in a cylindrical form, in a very fhort time, and apparently, to the height of a cloud, which at the fame time was rifing from the weft. The cloud, at this time, appeared to be low, and the front or foremoft part was projected nearly in a perpendicular direction, toward the head of the water fpout. The column of water, ftill increafing in height, at length formed a curve near the top, to meet the cloud, and quickly united with it ; at this time the cloud appeared to thicken and turn dark. The cone of water appeared at bottom, about two rods in diameter, and at about forty feet in height ; it appeared to be about three or four feet in diameter ; thence, of the fame bignefs, to the cloud, and all appeared very black. This cone was furrounded with a mift or fpray of water, of about twenty rods in diameter at bottom, and in the fame conic form, to the height of about thirty or forty feet.

In about ten minutes after it had united with the cloud, the bottom of the fpout feparated from the pond, fo that the obfervers could fee under it, and as foon as it had thus feparat-

ed,

ed, it ſwiftly moved weſtward, acroſs the pond. When it came to the land, it twiſted limbs from trees, tore the buſhes and carried leaves and ſticks into the air. Croſſing the land for a ſmall diſtance, and coming to a brook, a ſmall column of water again aroſe from the brook, to the height of twenty or thirty feet, and pointed towards the foot of the ſpout which had ſeparated from the pond, and at this time was at a conſiderable height. In a ſhort time afterward, the whole of the ſpout aroſe and was all diſſolved in the cloud, without any ſudden or very uncommon fall of water. In about three quarters of an hour, or an hour afterwards it began to rain, and rained for about an hour very powerfully; but the ſhower was confined to the vicinity of the pond, and extended not far any way. The motion of the water, in riſing, was in form of a ſcrew, and the whirl or courſe of the water was againſt or contrary to that of the ſun. It appeared to run very ſwiftly.

I have collected this account from ſeveral reſpectable gentlemen in the neighbourhood of the pond, who were eye witneſſes to the phenomenon. One in particular, who gave me the moſt minute account, was within about eighty rods, and particularly attended to it.

Sir, if the foregoing will be ſerviceable in your philoſophical ſtudies, or in any other way, the views of your humble ſervant in tranſmitting it will be completely anſwered.

NEHEMIAH BENNET.

Hon. JOHN DAVIS, *Eſq.*

An

An account of ſome of the mineral productions in the State of New York, (accompanying ſpecimens tranſmitted for the Cabinet of the American Academy of Arts and Sciences,) in a Letter from BENJAMIN DE WITT, M.D. *Sec. N. Y. Soc. Agric. Arts and Manufact. F.A.A. F.H.S. &c. to* ELIPHALET PEARSON, *L.L.D. Correſponding Secretary of the Academy.*

DEAR SIR,

HAVING a convenient opportunity by the Rev. Mr. Kirkland to tranſmit to your Academy a ſett of the tranſactions of our Society for the promotion of Agriculture, Arts and Manufactures, inſtituted in the State of New York, which I promiſed you ; I alſo ſend by the ſame hand ſome ſpecimens of mineral ſubſtances from my collection, which the American Academy of Arts and Sciences will pleaſe to accept. I am fond of ſeeing collections of the ſubjects of Natural Hiſtory, and therefore willing to contribute my mite towards them. Indeed ſuch collections, when they become large, are not only highly intereſting as objects of curioſity ; but alſo of great uſe in the ſtudy of thoſe ſciences, which have nature for their ſubject, ſuch as Botany, Chemiſtry, Zoology, &c. They exhibit as it were in one view the natural hiſtory of a whole country, or of the whole world in proportion to their extent. They open to our eyes numerous pages in the book of nature, and allow us at once to read her beautiful and marvellous works. They preſent to us an elegant compendium of the creation, condenſed in the ſmall ſpace of a room. If the many

intelligent gentlemen, ſcattered all over our country, who poſ-ſeſs a taſte for ſuch ſtudies, were each to collect only a few of the curious objects that fall in their way, and tranſmit them to one luminous centre, ſuch as that of your excellent Inſtitution; we ſhould ſoon be in poſſeſſion of a complete natural hiſtory of our country. Diſcoveries would be daily made, and the moſt important benefits reſult therefrom. The many plants and foſſils which now perhaps are emboſomed in the wilderneſs, or buried in the earth, would be brought to light, and applied to the moſt uſeful purpoſes of life. I ſhould therefore wiſh to ſee our *American* academies of ſcience, Philoſophical ſocieties and other literary inſtitutions pay particular attention to this ſubject. I can promiſe you but a few ſpecimens at preſent, as follows.

No. 1. exhibits a ſpecimen of *iron ore*, procured from a mine near Weſt Point, in the vicinity of Hudſon's river. This ore is ſo rich that it will bear tranſporting in ſloops from there to Albany, and from thence a number of miles inland to a forge for the purpoſe of refining.

No. 2. *Iron ore* found in the townſhip of Marcellus, county of Onondago. This mine is known but by a few individuals, and not yet worked.

No. 3. *Bog ore* of iron found alſo in the county of Onondago, at no great diſtance from the ſalt ſprings.

No. 4. *Bog ore* of iron, very rich, found near the Ballſtown ſprings, and forged in large quantities.

No. 5. A ſpecimen of a beautiful milk white *Gypſum*, or plaſter of paris, of a carminated texture, and ſomewhat tranſparent, found in large quantities in the townſhip of Camillus and county of Onondago.

No. 6. The ſame *Gypſum* calcined by a gentle heat and fallen to powder, reſembling the fineſt flour in ſoftneſs and whiteneſs.

No. 7. A tranſparent glaſſy ſpecimen of the ſame kind of *Gypſum*, from the ſame place.

No. 8. A ſolid piece of *Gypſum* from the ſame place, and ſomewhat reſembling the former, but exhibiting an appearance like camphor on the ſurface of its tranſverſe fracture.

The body of Gypſeous Chryſtal, of which the foregoing are ſamples, lies about ſeven miles nearly weſt from the Salt Springs; and about a quarter of a mile ſouthward from where the main road to the weſtward croſſes the ſtream that runs out of the *Oſtiſco lake*, here called the Nine mile Creek. In conſequence of this ſituation, near the Oſtiſco lake and outlet, it is called the OSTISCO GYPSUM. From this place the waters are navigable with batteaux into the Onondago or Salt lake and Seneca river, affording a convenient tranſportation. The Gypſum is found againſt the banks of a gully, in which the waters that run through it in wet ſeaſons have worn a pebbly channel. The bank declines but a few degrees from a perpendicular. About ten or fifteen feet from the bottom the Gypſum is ſeen like a rock of chryſtal, which has been wholly covered with a

few inches of mould ; and ſeems to have been evidently diſcovered by ſomebody climbing up the bank and ſlipping the looſe ground from the ſolid ſurface of the Gypſeous rock with his foot. A ſurface of perhaps a yard in diameter has only been uncovered, and preſents an appearance which immediately gives you an idea that the body of the mountain is of the ſame ſubſtance. Although nobody has yet taken the pains of tracing it beyond the ſurface, which is mentioned as being expoſed to view. This plaſter of paris, or rather *Oſtiſco Gypſum*, exiſting to appearance in ſuch large quantity and of ſuch a ſuperior quality, muſt in time become of great uſe to agriculture and the arts. I believe it to be much preferable to the beſt kinds found in Europe, and uſed for the fineſt works.

No. 9. A more impure piece of *Gypſum* found about eight miles weſt of the main body above deſcribed, near where the weſtern road croſſes the outlet of the Schaneateles lake.

No. 10. An adulterated ſpecimen of *Gypſeous earth*, lying between two ſtrata of the impure ſtone in which it is embedded ; found in lot No. 35 of the Onondago reſervation, about two or three miles eaſt of the *Oſtiſco quarry*. It was diſcovered in digging a well ſix or eight feet below the ſurface of the ground. Theſe minerals being found in ſo many places, and at the diſtance of two, three and eight miles from the principal body, ſhews that the country abounds with them, and affords a ſtrong preſumption that they exiſt in very large quarries.

No.

No. 11. Suppofed to be an imperfect *Gypfeous ftone* of a blue colour, found in great quantities on the Cayuga lake. I have made no experiments on this; but it emits a fulphureous fmell when heated in the fire.

No. 12. Contains four varieties of *plafter of paris* from Nova Scotia, which, when compared with our's, will fhew the difference between the two.

No. 13. A *calcareous petrefaction* formed in the ftream of a fpring of running water; precipitated and concreted in large maffes, among the mofs.

No. 14. A fpecimen of the *calcareous concretion*, cemented round pebbles and various other ftones, dug out of the bottom of the falt fprings; and found under the earth in large bodies, along the declivity in the vicinity of the fprings. Of this nature I take to be the rocky bottom of all the falt fprings of Onondago, produced probably by a precipitation of the lime from the water. (See my memoir on the falt fprings and manufactories of Onondago. Agric. Tranf. N. Y. Soc. No. III. p. 99.)

No. 15. A fample of the *moffy plant* growing in abundance in the bottom of the falt lake, which in fhallow places may be feen almoft covering the whole of it. It ftill retains the peculiar fmell which feems to be imparted to it by the falt water. I fufpect it to be of the nature of the plant kali, and perhaps the mineral alkali might be obtained from it.

No. 16. A *red ſlaty ſtone* taken out of one of the ſalt ſprings.

No. 17. *Red ſtony fragments* of which the declivity from the high ground deſcending to the Salt Springs is compoſed. The earth alſo intermixed with this is of the ſame colour, reſembling the red ſoil of New Jerſey at Brunſwick; perhaps the water oozing through this earth may give that property to the ſalt water by which it colours the wood and ſurfaces of ſtones as it iſſues from the ſprings, although itſelf appears clear and tranſparent.

No. 18. *Salt chryſtalized* in ſmall chryſtals, procured from a pot of the ſalt ſpring water after it was boiled down.

No. 19. *Product of the ſalt water* by ſimple evaporation without ſeparation. It has a reddiſh tinge, owing to the calcareous earth, which is of that colour when ſeparated from the water in the act of boiling. The ſalt manufactured at theſe ſprings, ſo much reſembles the common white blown ſalt (only a little coarſer) that I think it unneceſſary to ſend you a ſpecimen of it.

No. 20. Appears to be a white ſoft *clay ſtone* found in great abundance in the townſhip of Camillus, Onondago county. In one place it underlays the ſoil for a large ſpace, covered about a foot or more with mould.

No. 21. The *ſame ſubſtance* reduced to powder, mixed into a paſte with water and dried. It remains yet to be determin-

ed

ed to what ufeful purpofes in the arts this may be appropriated.

No. 22. A *white foffil fubftance* found in large quantities at the little falls on the Mohawk river.

No. 23. A *yellow mineral fubftance* found on the eaft fide of the Cayuga lake near the water oozing out of the rocks and concreting to the fides of them. Ufed by the Indians as an emetic, and for the healing of fores.

No. 24. A beautiful *hexangular rock chryftal*, tranfparent as the pureft water, and perfectly polifhed on its furfaces.

No. 25. A pure *fand ftone* as white as milk, found in great abundance in a place between Poughkeepfie and New York. It is eafily broken to pieces, and much of it fpontaneoufly reduced to fand, which is principally ufed on the floors of houfes in its vicinity.

No. 26. A curious *annular ftone*, in the fhape of a circular ring, formed fingly in the centre of a bed of blue clay. I think it will puzzle the geologift to account for the manner of its formation.

No. 27. Contains *fixty four fpecimens* of as many varieties of ftones, to be found on the fhore of Lake Ontario. Their uncommon beauty and variety of colour, fhape, texture and difpofition firft engaged my attention ; and I fometimes amufed myfelf with making felections from them as I was walking along the water. The pebbles beat upon the fhores by the

furf,

ſurf, and worn in regular ſpherical ſhapes, are all a commixture of theſe varieties, and exhibit a ſingularly variegated appearance. An examination of this aſſemblage of ſpecimens will perhaps afford you a complete idea of the mineralogy of that part of the country. To account for the intermixture of ſo many different kinds of ſtone, many of them eſſentially diſtinct from each other; I firſt imagined that they might have been conveyed from different and diſtant parts of the lake by the motion and turbulence of the waters; and this indeed ſeems to be partially the caſe. But when I came to inſpect ſome parts of the banks I found all that variety interſperſed in great numbers among the clay of which they were compoſed. This is eſpecially true of that part of the ſhore on which the garriſon of Oſwego ſtands. It is here ſixty or ſeventy feet high, almoſt perpendicular, conſiſting of clay, reſting on a ſolid baſis of rock, nearly level with the ſurface of the water, where it exhibits a ſhattered appearance. Now it is almoſt impoſſible to believe that ſo great a variety of ſtones ſhould be naturally formed, in one place and of the ſame ſpecies of earth. They muſt therefore have been conveyed there by ſome extraordinary means. I am inclined to believe that this may have been effected by ſome mighty convulſion of nature, ſuch as an earthquake or eruption; and perhaps this vaſt lake may be conſidered as one of thoſe great *fountains of deep* which were *broken up* when our earth was deluged with water, thereby producing that confuſion and diſorder in the compoſition of its ſurface, which evidently ſeems to exiſt.

One

One of the *banks* of the *Oswego river* about a mile from the lake is entirely composed of strata of *free stone*, which appear to be superior in texture and beauty to those found in New Jersey. These will furnish a cheap and elegant material for the stately buildings which we may anticipate in a few years to be erected in the *city of Oswego* lately founded under the auspices of our legislature.

Albany, Sept. 2, 1799.

An account of the deleterious effects of Mephitic Air, or marsh miasmata, experienced by three men, July 27, 1797. *In a well, on the Boston pier; in a letter to the Rev.* JOSEPH WILLARD, *president of the university in Cambridge, and vice president of the American Academy of Arts and Sciences. By Rev.* JOHN LATHROP, *D.D. A.A.S.*

THIS well, like that which was dug some years ago on Minot's T, a part of the same pier, commonly called, the Long Wharf, is wholly surrounded with salt water, against which it is secured with clay and strong boxes.

The workmen had advanced about 27 feet before they experienced any inconveniency from bad air.

The several strata, through which they passed for good water, were,

 1st.

1ſt. About 15 feet, conſiſting of the materials of the pier.

2d. —— 14 feet, conſiſting of black mud, clay, ſand, and the heterogeneous ſubſtances which had been depoſited by the ſea.

3d. —— 4 feet and a half, conſiſting of very black mud, intermixed with the unconſumed roots of marſh graſs, ſhells and other marine productions.

After paſſing this ſtratum, the workmen began to bore.

4th. —— 30 feet of light blue clay.

5th. —— 23 feet of clay mixed with ſand.

6th. —— 7 feet of hard and dark blue clay.

7th. —— 3 feet of clay, ſtones and ſlate.

On the laſt ſtratum the workmen uſed the drill, and having broke through the cruſt of ſlate, the water guſhed up with great force, and roſe to about 12 feet from the ſurface, where it has ſtood ever ſince.

Upon entering the third ſtratum, conſiſting of black mud, intermixed with the roots of marſh graſs, ſhells, and other marine productions, the workmen perceived an uncommon fœtid ſmell. Faintneſs and difficulty of breathing ſucceeded, and to ſo great a degree, that they left the well, and could not be perſuaded to go down again.

Some hours after, a Mr. *Tileſton*, the maſter workman, who was not preſent when the labourers experienced a difficulty of

breathing, and left the well, having occafion to meafure the width at the bottom, in order to fix a curb, infifted on being let down. He had been at the bottom but a few minutes, before he was feen to fall, and remain without motion.

His condition, alarmed the other workmen, and one of them, whofe name was *Bunting*, was let down with a fmall rope in his hand, to pafs about the body of Mr. *Tilefton*, in order to pull him up; but before *Bunting* was able to make the rope faft, he fell.

Although the danger was now known to be very great, the anxiety to fave the two men, who were in a dying condition, was fuperior to the danger.

A Mr. *Hancock*, contrary to the advice of all prefent, went down, but no fooner reached the bottom, than he fell with the other two.

There were now three men, lying apparently dead on the bottom of the well.

A fea faring man, whofe name is *Clarke*, came to the place, at that moment, and would have immediately gone down, had not Mr. *Jonathan Balch* (who furnifhed me with the materials for this communication) prevented him, until, by an experiment which he had tried on a like occafion, he might leffen the danger.

A common mat, fuch as merchants wrap about bales of goods, was faftened to a rope and let down. By working this

mat

mat very quick up and down, the heavy mephitic air, was ſo mixed and diluted with the more pure air, in the upper part of the well, that the men who lay in a dying condition at the bottom, experienced the benefit. In a little time they ſhowed appearances of life, by moving their limbs.

Mr. *Clarke* was then let down, and by taking one after another in his arms, he raiſed them from the horrible pit, in which they muſt have ſoon died, had not timely aid been afforded them.

The *ſtratum* of black mud, intermixed with the roots of graſs, and the relics of the ſea, twelve or fourteen feet below the preſent flats, is a curious article in natural hiſtory, and affords evidence, that the peninſula of Boſton is now, very different in its dimenſions, from what it was many ages ago.

With great eſteem,

I am, Sir,

Your moſt humble ſervant,

JOHN LATHROP.

Rev. Dr. Willard.

Fatal

Fatal effects of Lightning; in a letter to the Rev. JOSEPH WILLARD, *president of the university in Cambridge, and vice president of the American Academy of Arts and Sciences. By Rev.* JOHN LATHROP, *D.D. A.A.S.*

Boston, July 1st, 1798.

REV. SIR,

IN compliance with the requeſt of the Academy, expreſſed at the laſt meeting, that the ſeveral members would communicate ſuch caſes of the effects of lightning, as may have come to their knowledge, I have the honor to communicate the only caſe which has happened in this town, ſo far as I can learn, in which life has been deſtroyed by a ſtroke of lightning.

The account which I am about to give has been communicated to me by Mr. Benjamin Henderſon. Mr. Henderſon is now 72 years old, and as he was 12 at the *time*, he has a clear remembrance of the thunder ſtorm, and of the effects.

He informs me that he then lived with his mother in the houſe which makes the north ſide of the arch, leading to the dwelling houſe of the late Jonathan Williams, Eſq. There were in the room five gentlemen belonging to the general court, himſelf, his ſiſter, and Deborah Stratton, the young perſon who was killed.

As the ſtorm increaſed, this Deborah, a child of about 13 years old, being intimidated, ran to one of the gentleman, who

ſat

ſat very near a window, and placed herſelf on the floor between his feet; covering her head with the ſkirt of his coat. Mr. Henderſon, who gives me the account, ſat alſo on the floor, not more than two feet from the fatal ſpot.

The cloud came up in the weſt, and in the midſt of the ſtorm, there was a violent diſcharge of thunder, which burſt off the caſing of the window near which they ſat, carrying pieces of the boards to the middle of the room, and filling the whole with a ſtrong ſulphureous ſmell.

As ſoon as the perſons in the room were recovered from the firſt impreſſion, they found the girl was dead. Mr. Henderſon, who gives me the account, was for ſome time inſenſible of what had happened. His ſiſter was alſo ſtruck down. He tells me, he had no recollection of the *clap*, but as he came to his ſenſes, he ſaw the girl dead, and found himſelf ſo injured that he could not ſtand. He was put to bed, and in the morning he found one of his arms was burnt and bliſtered; and ſeveral days paſſed before he recovered the uſe of his limbs.

I cannot determine from any circumſtances related whether the diſcharge was from the cloud, or from the earth. The caſings of the window, indeed, were flung *into* the room, but it appears from careful obſervation, that ſlivers and light pieces of wood, were driven, at the time of exploſion, in every direction from the place where a breach is made.

In the cellar, and directly under the place where the unfortunate child was ſitting, there was an iron ſpit, the one end

of

of which ftood on the ground, and the other refted on the cellar wall.

The fharp end of the fpit, which refted on the wall, was melted ; and directly over the fpit, there was a fmall breach in the floor of the room.

If the charge was from the earth, the fpit conducted it in fafety, as far as it reached ; and as the electrical fluid is always condenfed, and acts with moft force, at going off, or entering the fharp point of a conductor ; it melted the end of the fpit, as now defcribed. The charge then took the neareft good conducting matter, which happened to be the unfortunate child, fitting on the floor, directly over the fpit. In paffing through the floor, it is probable the fluid diverged ; the greateft part paffed through the child, and produced inftant death. A fmaller portion took Mr. Henderfon's arm, and burned it ; the whole then took the iron hinges, and hooks of the window, and the lead in which the glafs was fet, and fo paffed away without leaving any other marks of its progrefs, except throwing a few bricks from the chimney ; or, if the charge was from the *cloud*, the effects and appearances would probably have been the fame. This accident fhows the danger of placing ourfelves in the courfe, between different portions of conducting matter, in the time of a thunder fhower.

The iron fpit, ftanding by the wall, in the cellar, and the lead and iron work of the window, were good conductors. The explofion, whether from the ground, or from the cloud,

found

found the unhappy child between thoſe portions of conducting matter, and killed her in a moment.

It is remarkable, that the gentleman, between whoſe feet ſhe ſat, and with the ſkirt of whoſe coat ſhe covered her face, received no hurt.

Auguſt 14*th.*

SINCE writing the above, another perſon, an inhabitant of Boſton, has been killed by lightning.

On the tenth inſtant, five men were employed, by the ſelectmen of the town, to take a corpſe, which had lain in a place unfrequented, until it became extremely offenſive, and bury it on a ſmall iſland in the harbour.

While digging the grave, they obſerved a cloud gathering nearly over them. As one of the men was at work in the grave, and two others were ſtanding very near, there was an unexpected diſcharge of lightning, which ſtruck to the ground the two men who had been ſtanding by the grave, one on each ſide.

The man who was then *in* the grave, tells me, the clap ſeemed to him like the report of two or three cannon, in as quick ſucceſſion as poſſible. He inſtantly looked up, and ſaw the two men lying on the ground. With ſuch aſſiſtance as he, and the other men were able to give, one of the two, who were ſtruck, was ſoon recovered; in the other, whoſe name

was

was *James Dill*, no remains of life were ſeen ; his hat was torn very much, and was lying ſeveral feet from him. There was a breach in the ſkin of his head, from which the blood ran down his face. From the breach in his head there was a duſky appearance like that which is made by the burning of gun powder, down his neck and breaſt, and ſo (chiefly on the left ſide) to his feet.

Col. Revere, who in the diſcharge of his duty as coroner, examined the body, tells me, he obſerved the breach in the ſkin of the head, and alſo a white mark, like a *ſcratch*, down the neck ; which he thought, was over the jugular vein ; and on each ſide the white appearance, there were duſky ſtreaks as deſcribed before.

The man who was killed, had on a pair of ſtrong canvaſs trowſers, both legs of which were torn open ; the left in two or three places.

As the members of the academy wiſh to have every circumſtance communicated, which carries evidence to ſhow the direction of the charge, I will ſubmit the following reaſons to ſhow, that in this caſe, the earth was *poſitive*, and the direction of the charge was upwards.

The morning of the day, and all the forenoon, was extremely hot, with the wind, very ſmall, moſt of the time, from the weſt. After a ſhort calm, about 12 o'clock, there was a light breeze from the eaſt and ſouth eaſt, and in a ſhort time clouds began to appear.

According to the theory, which I believe is now generally received, the eaſt and ſouth eaſt wind having taken from the atmoſphere, a portion of the electrical matter, the particles of vapour, which had been ſeparated by it, approached nearer each other, and appeared in clouds. As the region of the atmoſphere, in which the clouds were thus formed, had been deprived of electrical matter, by the moiſt ſouth eaſt wind, the electricity of the clouds formed in that portion of the atmoſphere, muſt have been *negative*, until ſupplied with the fluid, from ſome other quarter. The cloud which we are now conſidering, I had obſerved with more than common attention from my houſe. It was *ſmall*, but appeared very much condenſed by the action of oppoſite winds.

The men who were on the iſland ſay, there had been no rain or thunder from the time of their landing; the fatal *clap* was the *firſt* diſcharge. As a portion of the electrical matter had been taken off, before and at the time when the cloud was forming, and the clap which killed the man was the *firſt*, there is reaſon to think the charge went from the ſpot on the iſland, where he ſtood, to the cloud, and ſo reſtored the *equilibrium.* Some circumſtantial evidence, that the electricity of the earth was *poſitive*, perhaps may be gathered from the burſting open of the canvaſs trowſers, the tearing of the hat, and the breach in the man's head. The electrical fluid paſſing from the earth, directly under the man, tore aſunder the dry linen trowſers, which were open at the bottom, and tight at the top. The hat alſo, being of wool, and dry, was a bad conductor. It gave ſome obſtruction to the paſſing fluid, and was therefore

torn in pieces, and driven to ſome diſtance. This reſiſtance might alſo give ſuch a direction to the fluid, as to break the ſkin; a thing not common even where ſtrokes of lightning have been fatal. But whether the thoughts now ſuggeſted carry any evidence to prove that the electricity of the earth, in the caſe we have been conſidering, was poſitive, or not, I hope others who have given more attention to ſtudies of this ſort than I have been able to, will be led to make ſuch communications as ſhall ſerve to illuſtrate this intereſting branch of natural philoſophy.

With great reſpect and eſteem,
I am, Sir,
Your moſt obedient,
And humble ſervant,
JOHN LATHROP.

Rev. Dr. Willard.

An account of the effects of Lightning on the houſe of JONATHAN MASON, *Eſq. in Boſton. In a letter to the Rev.* JOSEPH WILLARD, *D.D. L.L.D. and vice preſident of the American Academy of Arts and Sciences. By Rev.* JOHN LATHROP, *D.D.*

SIR,

ABOUT 2 o'clock, P. M. on Wedneſday the 23d of May, a cloud, which had been ſeveral hours collecting in the weſt and north, came up with a briſk wind and heavy claps of

of thunder. Soon after the rain began to fall, the wind veered to the north, and brought over a very thick cloud, which had been collected in that quarter. The rain now came in torrents, mingled with hail and fire.

A few minutes after 2 o'clock, a discharge of lightning struck a ship at the Long Wharf, which shivered one of the masts to pieces. Another discharge struck the house of Jonathan Mason, Esq. in Marlborough street, and as the effects are somewhat curious, I beg leave to relate them. The house is of brick, three stories high, facing the street to the west, with a new end of wood at the north. It is furnished with a good conductor, fastened to a chimney, and passing down the north end by the brick wall. The whole charge of lightning passed down the conductor, without any injury, except loosening two or three of the iron staples, with which the conductor was fastened, until it came to about 10 feet from the ground. The charge then divided in the following manner: A part passed down the conductor, splitting upon the small trunk or box, which enclosed it, near the ground; but as the earth was not sufficiently wet to carry off the charge, there was an explosion, which burst through the cellar wall. The cellar door, which was shut, was very near the place where the lightning burst through the wall. The iron ring of this door attracted a part, or the whole of the lightning, which entered the cellar at this place, and by the nails sent it out again into the open air, ripping off the wood on the outside of the door, where the nails were clinched.

We

We are now to follow a portion of the charge which flew off from the conductor, and entered the new part of the houſe, at about eighteen inches from the conductor, and about ten feet from the ground.

In the inſide of the room, directly againſt the ſpot where the lightning tore off the clapboards and entered the houſe, three or four long and ſlender pieces of iron are driven far into the wood work, to which the machinery for the houſe bells is fixed. From this centre, the wires are carried into the different rooms. I will now relate the effects of the lightning, as they are to be ſeen in the different rooms. A part of the charge was received by the wire, which leads from the above-mentioned centre, directly to the kitchen. This portion of the fluid paſſed through three partitions of wood and plaſtering, without any damage, until it reached the kitchen. The houſe keeper, who was at the time near the kitchen door, ſays, the firſt ſhe perceived was the ringing of all the bells, and at that inſtant, ſhe ſaw a crinkling of fire about the laſt bell; as there are four in a line, and connected by the ſame wire; and in an inſtant the exploſion from that bell, was ſuch as deprived her of her ſtrength, and had ſhe not held by the door, ſhe muſt have fallen. This diſcharge from the bell, as there was no good conductor near, ſtruck a number of earthen diſhes from the ſhelves, and paſſing through a ſmall opening at the bottom of the dreſſer, burſt into the cellar, tearing off the lath and plaſtering, which were carried to a conſiderable diſtance.

Another

Another portion of the fluid was received by the wire, which leads from the fame centre, through the north front room, to the great entry. Upon entering the entry, the wire was melted, and falling on a dry mat on the floor, fet it on fire. This portion of the charge lofing its conductor, was attracted by the lower hinge of the front door, and conveyed out by the nails, as in the cafe of the cellar door abovementioned. Another part of the charge was carried from the fame place of entering, by a wire, which paffed through the north front room, acrofs the great entry, and along the cornice of the fouth front room, then turning at a right angle, along the cornice on the fouth, to the crank and bell cord by the fire place.

The portion of fluid, which took this direction, melted the wire foon after it entered the fouth room. It then took the curtain rod of the window neareft the front entry, and as it had no good conductor from the curtain rod, there was probably an explofion, for the curtain was fet on fire, with the cornice, and the wood work about the window. A large looking glafs, which hung between the windows, was broken; part of the charge then took the remaining part of the broken wire, and followed it round to the fire place; but as the cord which hung down with the taffel, made a bad conductor, the charge flew off from the wire oppofite to the corner of a large picture of prefident Wafhington, which hung over the breftwork, made a fmall opening from the back through to the gilding, ran down the fide gilding to the bottom, leaving a dufky mark, and from the picture, paffed down to the fmall opening

between

between the breſtwork and the marble mantle piece, entered the chimney and went off.

It may be a queſtion, why the whole charge did not go down the conductor to the earth ?

I imagine the rod did not enter ſufficiently deep into the ground. From its exploſion through the cellar wall, it is evident the earth was not ſufficiently wet to carry it eaſily off. Meeting with an obſtruction in its direct courſe, it ſought another ; and the irons for the bell machinery, abovementioned, afforded the moſt ready conducting matter. The water alſo, which fell in a torrent, rendered the paſſage of the lightning eaſy, from the conductor to the part of the houſe where it entered.

With two obſervations I will finiſh this account, which I fear is too long.

The firſt is, that the part of the rod which enters the ground, ſhould go deep enough to be always in moiſt earth, and that it ſhould turn *from* the building. Had theſe things been attended to, it is probable there would have been no exploſion into the cellar from the foot of the rod.

The other is, that great care ſhould be taken not to have any good conducting matter *near* the rod. The iron machinery for houſe bells, being about eighteen inches from the conducting rod, no doubt, attracted that portion of the charge, which entered the houſe, and produced the effects which have

been

been related. Happily for the family, none of them were eſſentially injured. Mrs. Joy, who was in the chamber, over the place where the lightning entered, was preſſed down, as with a heavy weight, and experienced a conſiderable degree of numbneſs till the next day.

With great affection and eſteem,
I am, Sir,
Your moſt obedient humble ſervant,
JOHN LATHROP.

Rev. Preſident Willard.

Obſervations on Electricity, and an improved mode of conſtructing Lightning Rods. In a letter, from the Hon. LOAMMI BALDWIN, *F.A.A. to the Rev.* JOSEPH WILLARD, *D.D. L.L.D. vice preſident of the American Academy of Arts and Sciences.*

Woburn, Jan. 25, 1797.

SIR,

THE partial effects of the electrical rods, which have been erected for the protection of buildings, &c. have led me to think, that they are not upon the beſt conſtruction, eſpecially thoſe that terminate in one point

The philoſophy of electricity ſeems to be enveloped in much obſcurity. Electrics and non electrics exiſt in nature ;

poſitive

poſitive and negative, progreſs and direction are properties not without their evidence, yet want explanation.

From the experiments and obſervations, which I have made, I am inclined to think, that upon the ſudden aſſemblage of the clouds, in the time of a thunderſtorm, the electrical fluid is excited and diſpoſed, unequally, in *ſtrata*, at different altitudes, which are continually varying in their ſituation, according as the exploſions of the lightning ſhift the power of attraction; and it is highly probable, that there are, at thoſe times, *ſtrata* of non conducting atmoſphere, intervening between other *ſtrata* differently affected. Now if this be really the caſe, and the height of the points of the rod do not happen to correſpond with the level of the *ſtratum* affected, the uſe of the rod will in a great meaſure be loſt.

It is a well known fact, that the electrical fluid enters and eſcapes by points and angles more readily than by ſpherical terminations.

From theſe circumſtances I think it muſt appear, that an electrical rod, prepared like the ſample which accompanies this paper, would be better adapted to equalize the fluid than the common cylindrical rods in uſe; for the infinity of points, or rather the continuation of them from the bottom to the top of the rod, provides for the entrance or eſcape of the fluid of any *ſtratum*, however affected, at any level, at or below the ſummit points; which, I think, muſt be conſidered an additional advantage; at any rate, ſuch a rod will anſwer

as well as the other kind. If gentlemen would make this addition, when they erect any new rod; the effect would ſoon be known, and it is my opinion that a rod might be denticulated in the manner propoſed, at leſs expenſe than ſquare bars could be reduced into a cylindrical form.

A rod, upon theſe principles, may be prepared in the following manner. Take a number of ſquare bars of iron, as they come to our market, of about an inch in thickneſs, and connect them together by a ſcarfed, or a halved joint at the ends, and ſecured with a ſcrew. When a ſufficient number of bars are thus connected to make the height intended (which ſhould always be as high as the rod can poſſibly be ſuſtained) then take them aſunder, at the joints, and place each ſingle bar in ſucceſſion, on a blackſmith's vice, with the jaws about half an inch apart, for one angle of the bar to reſt between, without bruiſing, while the workman proceeds, with a cold chiſſel, well prepared, to raiſe a barb, at the diſtance of every inch, or half inch, along the upper corner or angle of the bar, as it lays in the vice, and when that corner is done, bring up another angle, in the ſame poſition, and ſo proceed, until the whole are finiſhed.

Rods upon this conſtruction may terminate with three points; but I ſhould prefer a light ſtar, or glory, at the top of the rod, and the lower end ſunk pretty deep into the earth, perhaps to the level of the ſprings of water, and the hole filled up with charcoal about the rod.

Perhaps, in ſome particular ſtates of the atmoſphere, ſuch a rod might aſſiſt in reſtoring the equilibrium of the fluid among the *ſtrata* differently affected, by its entering at one place in the rod, and eſcaping at another, while the earth remained neutral.

If you think, that any thing can be collected from theſe hints to improve the electrical rod, I am willing they ſhould be communicated to the American Academy of Arts and Sciences for their conſideration.

I am with much reſpect, Sir,

Your moſt obedient ſervant,

LOAMMI BALDWIN.

Rev. Joſeph Willard, D.D. L.L.D.

Vice Preſident of the American Academy of Arts and Sciences.

Woburn, Jan. 25, 1797.

Remarks on the Hon. LOAMMI BALDWIN'*s propoſed improvement in Lightning Rods, in a letter from* AARON PUTNAM, *Eſq. to the Rev.* JEDIDIAH MORSE, *D.D. A.A.S.*

REV. SIR,

AGREEABLY to your requeſt, I now ſend you the few remarks I made the laſt ſummer, upon the communication of the Hon. L. Baldwin, Eſq. on electrical rods, publiſhed by order of the American Academy of Arts and Sciences, in the

Columbian Centinel, 11th Auguſt, 1798. Mr. Baldwin has very long and deſervedly held a high rank in the ſcientific part of ſociety; and no one, I preſume, has a higher opinion of him as a man and a philoſopher, than myſelf; and it is with diffidence I obſerve, that in my opinion, he has erred in his philanthropic intentions of rendering electrical conductors more beneficial to mankind. As they have been uſed, they certainly have not afforded complete protection; but from what cauſe they have failed, remains to be determined.

From a variety of experiments, which I have made on the ſubject, I am led to conceive of the matter relating both to the conductors, and the formation or *ſtrata* of the clouds, in a different point of view from Mr. Baldwin.

In the firſt place, I conceive heat to be the moſt ſubtle of all fluids; and of courſe the grand *primum mobile;* that heat has the power of diſſolving or liquifying air; the air of diſſolving water (the ſame as water has of diſſolving ſalt or ſugar) in ſuch manner as to render it inviſible to human ſight; therefore the greater the quantity of heat operating on the air, the larger the quantity of water that air will diſſolve and render inviſible. But apply any thing cold in contact with this warm air, thus filled with watery particles, and the air within the ſphere of the cold body, will immediately let fall the water. Of this, we have daily proofs in warm weather, when we bring into a room, where the air is in the abovementioned ſtate, a veſſel filled with cold water, a cold ſtone, or any ſub-

ſtance

ſtance colder than the air, we obſerve them ſweat, as the common expreſſion is, which is nothing more than the falling of the water contained in the ſurrounding air, brought within the ſphere of the cold body ; thus the watery particles of the breath, in warm weather, are inſtantly diſſolved on reſpiration ; but in cold weather, they are viſible, and in extreme cold, fall in groſs particles on the ſurrounding objects.

After ſeveral days of ſummer's heat, a large ſpace of air being in this heated ſtate, clearly eſtabliſhes this hypotheſis, and ſhews us the cauſe of thunder ſtorms. A column of cold air burſting into the rarified ſpace, deprives the warm air of the power to ſuſtain the water before inviſible ; condenſation takes place, which terminates in rain. Dry air, I conceive, to be a non conductor, or at leaſt a very bad one, and that air combined with a portion of water, may be rendered a very poor one, by the application of heat ſufficient to diſſolve that water ; but when the air in a given ſpace, is deprived of heat by a column of cold air coming in contact, and the watery particles condenſed, they become a conductor, and of courſe will receive the electrical fluid. Thus this column of cold air generating moiſture, as above ſtated, paſſes through a region of heated or dry air, and by it is in a degree inſulated ; and at the ſame time receives the ſmall portion of electrical fluid contained therein. A cloud thus formed has a ſphere, and within that ſphere, certain *ſtrata* differently charged at different times, but they appear to me of ſo ſhort duration, as to preclude the

neceſſity

neceſſity of providing a remedy for them ; for we witneſs the lightning conſtantly paſſing from one part of the cloud to the other, and thereby producing an equilibrium.

The electrical fluid being thus contained within the ſphere of the cloud, there is an emptying or attractive diſtance, which is larger than the ſtriking diſtance ; and a conductor brought within that attractive diſtance of the ſphere, would empty the whole cloud. This being the caſe, it appears to me a great miſtake to place rods for conductors, high in the air, above the object we wiſh to protect, for it is well known that no object will be ſo ſoon ſtricken as the conductor.

Under theſe circumſtances, we muſt have a ſtrong propenſity for emptying clouds, to run our conductor ſo high in the air as to empty the higheſt clouds that ſhould paſs, and thereby expoſe them to the ſtriking diſtance, when nine out of ten would paſs us, and not even come within attractive or emptying diſtance, provided our conductors were placed but a ſmall height above the object we wiſh to protect. The only reaſon I conceive, that can be offered in favour of carrying conductors high in the air, is to meet and empty the cloud ſooner ; but this appears to me an inaccurate mode of reaſoning ; for if ever a conductor fails to afford protection, it is when a cloud highly charged, approaches ſo rapidly upon the point, that before there is time for it to be emptied, the point is brought within ſtriking diſtance, and is then unable to carry off the quantity thrown upon it ; therefore, if the point is placed high

in

in the air, for the ſake of attracting it, certainly it is in the ſame ratio expoſed to be ſtricken.

From the preceding obſervations, I conclude, that a point eighteen *inches* above the higheſt object we wiſh to protect, would be much more ſafe than one of eighteen *feet.* As to the multiplicity of points, I believe them rather prejudicial than otherwiſe. The Hon. Mr. Baldwin obſerves, "it is a well known fact that electrical fluid enters and paſſes off by points and angles, more readily than by ſpherical terminations." I conceive the electrical fluid paſſing a rod properly prepared, to be the ſame, in a degree, as water paſſing a tube. For experiment, fix a tube with three or more branches, and pour water into each of the branches, at the ſame time, and you will perceive a very conſiderable obſtruction, where they unite in the common ſtock, or large tube, from the different directions of the branches. This I think will apply to the electrical fluid; and I have been confirmed in the opinion, from repeated experiments, that a conductor with one point properly fixed, would empty an electrical battery more readily than one with three or four.

I have two other objections to the rod propoſed by Mr. Baldwin. Firſt, Provided this rod, filled with points, from top to bottom, ſhould be ſtricken or overcharged, the electrical fluid would paſs off by theſe points in a variety of directions, much more readily, and of conſequence, be more liable to attach itſelf to ſurrounding objects, than if the rod were either round or ſquare.

Second.

Second. When the electrical fluid paſſes from the earth upwards. The earth, from its compoſition, is infinitely more liable to be charged unequally in *ſtrata*, than the air or clouds. When the lightning ſtrikes, as we term it, it is as often from the earth upwards to the cloud, as from the cloud to the earth; although I conceive this to be a caſe that will very ſeldom happen to a rod properly fixed, yet ſuch inſtances may occur; and moſt certainly the variety of points terminating in ſo many directions would be more dangerous, as before obſerved, than a rod with one point only.

I am ſenſible, ſome of the ideas I have here expreſſed, differ from the generally received opinions on the ſubject. I however think they can be ſupported. If they afford you any ſatisfaction, it will much gratify your very ſincere friend,

AARON PUTNAM.

Rev. Dr. Jedidiah Morſe.
Charleſtown, Jan. 12*th*, 1799.

Remarks on a Natural Phoſphorus. By Doctor SOLOMON DROWN.

Providence, Dec. 30*th*, 1786.

SIR,

AS the following relation of a phenomenon, obſerved at a place on Hoſack river, near its junction with the Hudſon, by Mr. Jeremiah F. Jenkins, a reputable merchant of this town;

town; has been thought by ſeveral gentlemen here, worth communicating to the American Academy. I was led by the advice of my ingenious friend, Mr. Benjamin Weſt, to addreſs it to you.

Some time laſt October, Mr. Jenkins was at his friend's houſe, at *Schaghticook*, on the Hoſack; and going with him into his ſtore, in the evening, they diſcovered on the floor, the appearance of ſcattered fire, which at firſt was ſuppoſed to be rotten wood; but on ſtooping down, it had a more luminous appearance. This induced Mr. Jenkins to put his finger on a ſmall piece, which he drew along on the floor, a lucid train ſucceeding, and retaining its brightneſs. He then rubbed it in a circular manner, to about the ſize of a crown, and left it to call ſome perſons from the houſe adjoining, to ſee this extraordinary appearance.

On returning with the company, he undertook to ſhew them the effect of rubbing another piece, about the ſize of a parſnip ſeed; and proceeding as before, till it was about double the ſurface mentioned (the brightneſs as in the firſt experiment) it ſuddenly flaſhed into a blaze, ſet the floor on fire, and had the effect of the moſt powerful cauſtic on his finger; which, through extreme pain, being rubbed againſt his thumb, affected it equally, both being exceſſively burned. In this diſagreeable ſituation, he attempted to extinguiſh the fire, by plunging his hand into a baſon of water repeatedly, holding it under once fifteen or twenty minutes; during the moſt of which time, the finger and

and thumb were free from pain ; yet when expoſed again to the air, the fiery appearance and pain returned. He was then led to waſh them in water, with plenty of ſoft ſoap,* which extinguiſhed the lucid appearance, though the pain continued.

The attempt to extinguiſh the fire on the floor was attended with the ſame difficulty ; nor was the flaſhing ſuppreſſed till after repeated ablutions. He obſerves that the blaze had the appearance and ſmell of burning ſulphur. Two pieces being preſerved, one in paper, the other in a ſilver ſalt celler, till next day, the firſt, on examination, appearing partly diſſolved, was wrapped in a freſh piece of paper, and put in a ſmall cloſe trunk. On taking it out to examine again, it unexpectedly flaſhed into a blaze, and was conſumed with the paper. The other piece, he brought with him in a ſmall ſnuff box. This retained its luminous appearance ſeven or eight nights without friction, a lucid vapour ariſing from it on opening the box.

Mr. Jenkins conjectured, that it might have been conveyed into the ſtore from the neighbouring bank of the river, by adhering to the foot of ſome perſon ; and to ſtrengthen this ſuppoſition, mentions the report of boys' having obſerved ſomething like fire flaſhing from the bank, when fiſhing in the evening.

The box herewith encloſed, contains only a very ſmall piece of this matter adhering to one ſide. When laſt examined, it had not ſo far loſt its properties, but that a piece, the ſize of a

 pin's

* Query, whether the alkaline ſalt of the ſoap did not neutralize the phoſphoric acid, in this natural production?

pin's head, rubbed on ſmooth paper, would exhibit a luminous appearance in the dark.

We are ſorry, that the quantity brought was not ſufficient to be ſubjected to proceſſes for aſcertaining its component parts. May they not be a calcareous earth, for the baſis, and vitriolic acid, united with phlogiſton, into a highly inflammable ſulphur?

Should the vitriolic acid be procurable from this ſubſtance, it might well pay the reſearches of thoſe, who ſhall effect the diſcovery of its bed.

Happy, if I can, by any means, conduce to the advancement of American ſcience,

I am, with the greateſt reſpect, Sir,

Your moſt obedient humble ſervant,

SOLOMON DROWN.

Rev. S. Williams, L.L.D.

Obſervations upon the art of extracting Marine Salt from ſea water, by evaporation, produced by the ſun's heat; with a deſcription of the works, and the ſeveral proceſſes uſed in preparing Medicinal Salts, and Magneſia Alba. By JAMES THACHER, *M.D. F.A.A.*

EVERY eſſay having in view the advancement of our manufactories, and encouraging the efforts of induſtry, will, it is preſumed, receive the approbation of every claſs and de-

ſcription

ſcription of ſociety. From this ſource, reſults that ſubſtantial advantage, to realize which, the public has an undoubted claim upon the energy and exertions of individual citizens. An enterpriſe, which aſſociates private emolument with general intereſt, may with peculiar propriety be recommended to the conſideration of the community.

While then the active labourer is employed in exploring the bowels of the earth for riches, while the adventurous ſeaman hazards his ſafety upon the ſtormy billows, traverſing the mighty deep in purſuit of treaſure, ſhall we not reach forth our hands to receive that bounty of providence, which conſtantly flows at our ſhores, and daily waſhes the borders of our farms?

Theſe preliminary remarks have reference to the art of extracting common ſalt from ſea water by evaporation, which till within a ſhort period was unknown among the inhabitants of this country, and even at this time a knowledge of the buſineſs is confined almoſt excluſively to the ſhores of Cape Cod.

A want of particular information reſpecting this productive branch of manufacture, has hitherto prevented its being more extenſively beneficial. An apology therefore for this communication, were it not for its imperfections, would be unneceſſary. Let it however be obſerved, that in endeavouring to aſſiſt the uninformed artiſt, I am not ſolicitous to vie with thoſe who are in purſuit of literary fame.

The method of preparing and refining ſalt in the ſalterns in different parts of Europe, would not comport with the circum-

ſtances

ftances of our country. The fuperior advantages of our procedure confifts in diffipating the water without the expenfe of fuel, the furnace and other apparatus for boiling. "The fuel alone expended in fome of their falterns, cofts more than two thirds the value of the falt." Omitting therefore any particular detail refpecting the proceffes ufed in the preparation of falt in other parts of the world, the fubfequent obfervations will relate entirely to the fuccefsful experiments, which commenced with, and are now profecuted by the induftrious inhabitants of Cape Cod.

During the diftrefsful period of our revolutionary war, Mr. John Sears, with two or three affociates, were the firft who commenced at Dennis the manufacture of falt by evaporation; their unpromifing attempts were deemed chimerical; but by a commendable perfeverance, they repelled the obloquy of the incredulous, and in due feafon realized a profit exceeding their moft fanguine expectations.

The undertaking has fince been greatly improved, and become an eftablifhment meriting public confideration, and as refpects the peculiar circumftances of the inhabitants upon the Cape, may be viewed as an acquifition of ineftimable value.

The works now erected in the county of Barnftable, from their advantangeous fituation and extent, are calculated to produce annually an immenfe quantity both of marine and glauber falt; the particular amount cannot at prefent be afcertained. One man in the town of Yarmouth, has upon his farm

farm a valuable ſet of works, conſiſting of 130,000 ſuperficial feet; the annual produce of which he eſtimates at upwards of 520 hogſheads of marine, beſides a due proportion of glauber ſalt, amounting to about nine tons. This gentleman, with many others, are now augmenting their works in the confident expectation of realizing a clear profit from 25 to 35 per cent. Some works poſſeſſing peculiar advantage in point of ſituation, have yielded a greater profit; and proprietors in general calculate upon defraying the expenſe of their works in four or five years. The average produce, is for every 1000 ſuperficial feet, 33 buſhels of marine, and 150 lbs. glauber ſalts. The quality of the ſalt is equal to any imported. It weighs 80 lbs. per buſhel, and is decidedly ſuperior in point of ſtrength to foreign ſalt, if in this reſpect we except that which is made during the extreme heat of July and Auguſt, which in conſequence of a haſty evaporation, retains a portion of the bittern. This weakens the ſalt, makes it more ſoluble, and leſs proper for domeſtic uſe than that manufactured in the more temperate months. Liverpool ſalt is ſo ſtrongly impregnated with lime, that fiſh cured with it have the appearance of being *whitewaſhed*, which greatly injures their market.* Our works are remarkably well adapted to free the ſalt from this and other impurities; and it is from the ſeparation of this ſubſtance, that our ſalt acquires its peculiar whiteneſs and purity. Conſidering the duty impoſed on foreign ſalt, the freight

* For ſome of theſe particulars, I am indebted to the information and intelligence of the Reverend Mr. Briggs of Chatham.

freight and charges of that bulky commodity, our manufactories can even in time of peace afford to underſell our importers.

When therefore, our enterpriſe ſhall have progreſſed to that deſirable extent to which the importance of the object, and the ſucceſs of our experiments encourage us to hope, we may exhibit upon our ſhores a ſource of wealth little inferior to the celebrated ſalt mine of Cracow.*

John Sears and Hallet Kelly, late of Dennis, have both obtained patents for their different plans of conſtructing the works, which are held in competition, nor has experience ſatiſfactorily decided, which poſſeſſes the ſtrongeſt claim to preference.† Their reſpective advantages, however, will appear from the particular deſcription which follows.

In the firſt place a commodious ſituation near the ſhore ſhould be made choice of, where the rays of the ſun can fall with the greateſt poſſible effect; and to render this more efficient, the vats ſhould be built in a line extending from eaſt to weſt. Conformably to Sears' plan, a vat 16 feet wide is to be erected on ſtands of cedar rails or other ſmall timber, at a convenient

* Some of the ſalt mines are of amazing magnitude, the ſingle mine of Cracow in Poland, is computed to hold ſalt enough to ſupply the whole world for many thouſand years. There are houſes, chapels, &c. under ground all built of ſalt, or the ſalt ſtones. The foſſil is cut and turned into pillars, altars, crucifixes, images, &c. Oftentimes it is naturally cryſtallized into very curious figures. Maſſes are ſometimes brought up weighing from 20 to 30 cwt. *Neumann's Chem. Vol.* 1. *page* 330.

† Sears' patent is conteſted upon the principle of his not being the original inventor, which queſtion is now pending before the Circuit Court for deciſion.

convenient height from the ground, care being taken to place a double board under every ſtand to prevent their ſettling. The frame is commonly formed of pine, hemlock or other joiſt. The largeſt or ſide timbers being 4 by 5 inches, and the middle ones 3 by 4. The floor is made of good ſeaſoned boards, nailed upon this frame. A piece of plank, about ſix inches in width, is placed upon its edge on the top of the outſide timber, reſting upon the ends of the floor boards, and firmly ſecured by upright pieces, trundled on the outſide, at proper diſtances from each other, in the form of dovetail; but an improvement in this method is, that the gunwale plank ſhould ſupply the place of the ſide timber, having a groove within one inch of its lower edge, into which the ends of the floor boards are inſerted. This building muſt be divided by plank partitions into three apartments; the water room being the largeſt, muſt occupy two thirds of the whole; the pickle room takes up two thirds of the remainder, and the reſidue is aſſigned for the ſalt room.

The two laſt rooms muſt fall each a few inches below the one immediately preceding, for the convenience of drawing off the liquor.

It is a point of importance, that the floor of the ſalt room in particular, be perfectly tight; to this end, none but the beſt of ſeaſoned boards, planed on one ſide, and entirely clear of ſap, and looſe knots ſhould he uſed. The joints, eſpecially under the gunwale, ſhould be caulked and payed. The cov-

ers

ers or roofs ſhould be made as light as poſſible; they muſt, however, effectually ſecure the vats from rain, as that would greatly injure the proceſs, by diluting the pickle, and impeding the evaporation. They are in the form of the common pitched roof with gable ends. They ſhould be ten feet in width, ſo that a vat one hundred feet long, will require ten covers. The two pieces of croſs joiſt, which ſupport the roofs, are furniſhed with ſhivers, or ſmall wheels of caſt iron, or hard wood, and alſo ſide ſhivers, placed horizontally, to accelerate their motion. Small ſtrips of plank ſhould be extended from the vats, ſupported by proper ſtands, for the purpoſe of rolling off the covers. The roofs have uſually been covered with ordinary boards, except thoſe over the ſalt room, which we are adviſed to ſhingle; but a better method unqueſtionably is, inſtead of boards, to cover the frames with ſhingles nailed upon ſmall rafters. In either caſe I would urge the expediency of painting the roofs white, for the double purpoſe of preſerving the wood, and its power of increaſing the reflection of ſolar heat.

The invention of the late Hallet Kelly, comes next under conſideration; he directs the vats to be made in the form of a parallelogram, 20 by 40 feet; two of theſe join together at their angles, and communicate by a ſpout. At the angular point is erected a perpendicular poſt of a proper height, upon the top of which is balanced a large croſs beam, firmly braced; the covers upon this plan have hipped roofs, are twenty

feet fquare, being a pair to each vat, and fufpended one at each end of this beam; may be compared to a pair of brafs fcales inverted with their beam placed upon a fulcrum. The poft is furnifhed with a pivot at the bottom, turns off in the manner of a crane, and the covers then occupy the interval between the two vats. Thus a line of works may be erected of an indefinite length in zig zag form, with a crane poft ftanding alternately between every vat, and the whole to be connected by fpouts.

It will at firft view be perceived, that this piece of machinery is calculated to turn with great eafe and celerity, and it is conceded that a greater extent of works can be covered and uncovered in a given time upon this, than the former plan; but it is objected by the advocates of Sear's method, that the fufpended weight will derange the poft, and repairs become frequently requifite; that they do not fo effectually fecure the vats from rain, and that they occupy more ground than the others. Some gentlemen, however, in whofe hands both methods have paffed the teft of experience, affure me, that Kelly's invention deferves the preference, although the difference in the coft is eftimated at 7 per cent. In fact the works upon either plan are completely under controul, and require very little manual aid to cover them, when rain is expected.

Contiguous to the vats, it is neceffary to erect a mill and pump for every 20,000 fuperficial feet of works, to complete the apparatus. The pump is placed in a fmall ciftern,

ſunk to the level of the tide water, from which is carried a ſubterraneous pipe, towards low water mark. A ſmall windmill, with canvaſs ſails, being now connected with the pump, the water is thrown into ſpouts, and conveyed to every part of the works, as occaſion may require. Having now completed the machinery, and brought the proprietor to that ſtage of the buſineſs in which he may anticipate his compenſation; it is next incumbent upon me to deſcribe particularly the proceſs, by which the different kinds of ſalt are uſually obtained. In doing this, I ſhall have regard to the order in which the occurrences will ſucceſſively reſult.

The water being pumped into the water room, immediately after being finiſhed, that the work may ſwell and become tight, ſhould continue there until a conſiderable part of it has evaporated, and the reſidue acquired the ſtrength and ſharpneſs of brine. The plugs are then to be withdrawn from the partition, and the liquor let into the pickle room. The length of time required for its continuance in the firſt room, muſt evidently depend upon the degree of heat to which it has been expoſed; but for the preciſe time of drawing the liquor out of the pickle room, we have a more correct criterion; for in this ſtage of the proceſs, a calcareous earth or lime begins to appear upon the ſurface, and ſoon ſubſides to the bottom in the form of a white earthy powder. Soon after this occurrence, the liquor being almoſt fully ſaturated with ſalt, exhibits a ſaline pellicle upon its ſurface; and in a dry day ſmall cryſtals begin to form, which immediately concrete into corns, reſembling

bling hail, and precipitate to the bottom. The ſubſidence of the lime, therefore, and the appearance of granulated ſalt, mark the point of time, when the pickle ſhould be drawn into the *ſalt room*. In this laſt ſtage of the proceſs, the liquor from further evaporation becomes highly concentrated, and the ſalt, accumulating upon the floor, aſſumes its natural cryſtalline form.

The ſalt ſhould remain in the ſalt room, till a large quantity is procured, and more pickle added to it occaſionally. When removed into the ſtore houſe, ſhould be placed upon a ſhelving floor, that the ſaline liquor may be entirely drained from it.

The next ſubject that ſhould arreſt our attention, is the preparation of the two kinds of medicinal ſalt procured at the works. The firſt is obtained in the form of large beautiful cryſtals, ſcarcely diſtinguiſhable from the genuine ſal mirabile, or glauber ſalt, and is found to be equal in quality to the beſt imported ſalts uſed in medicine. The manufacture of this valuable article is progreſſing to ſuch extent and perfection, as to meet the demand of the United States, and render importation altogether unneceſſary. It has alſo become an article of ſome conſequence in commerce. Many tons of it are annually exported to the Eaſt and Weſt Indies, where I learn it comes to a ready and profitable market. Some objections have been made to this ſalt, on account of the large ſize of its cryſtals; but this circumſtance does not affect its medicinal virtues, and its repute in medicine has the ſanction of experience.

This

This ſalt is procured during the cold weather in winter, from the pickle or brine in its concentrated ſtate, and the ſame reſult will enſue, whether we have recourſe to the proceſs antecedent or ſubſequent to the cryſtallization of the ſea ſalt. Having procured a quantity of pickle, ſufficiently inſpiſſated in the ſalt, it is to be expoſed to the cold weather in the vats during the winter, from the effects of which the ſalt will be found to ſhoot into irregular cryſtals, and precipitate to the bottom. In order to purify this ſalt, it muſt be taken out, put into a copper boiler, being firſt half filled with warm freſh water, with which the ſalt is to be diſſolved and boiled for ſome time. The ſolution, after ſtanding an hour or two in a wooden veſſel for the fæces to ſubſide, ſhould be poured off from the ſediment into coolers, where the ſalt will immediately form into perfect cryſtals; ſhould the ſalt not be quite pure, nor aſſume the form of regular cryſtals, it may be rediſſolved, and the operation repeated. After the cryſtallization of both marine ſalt and ſal glauber, there remains upon the floor of the ſalt room a ſaline bitter liquor, called mother, lye or bittern. This liquor has commonly been thrown away as uſeleſs; but the workmen ſhould beappriſed that it will yield both a neutral ſalt and magneſia alba. If this bittern be ſet by in a cold place for ſometime in a leaden veſſel, a quantity of glauber ſalt, before mentioned, will ſhoot; and if the remainder of the bittern be gently evaporated farther, a freſh quantity of the ſame kind of ſalt will appear; but if the bittern be haſtily evaporated by

by boiling, and ſet by to cool, ſalt will be produced in the form of fine delicate needle point cryſtals; having, when taken out of the liquid, the appearance of ſnow. This is no other than the genuine bitter cathartic ſalt of Epſom, ſo called from the mineral ſpring of Epſom, where it was originally diſcovered by Dr. Grew. Although this and the glauber ſalt are in their chymical properties eſſentially diſſimilar, they are in medicinal virtues nearly allied, and often preſcribed indiſcriminately. Another article in the preparation of which ſome attempts have been made at the works on the Cape, is magneſia alba. The ſpecimens of it, which I have inſpected, are manifeſtly inferior to Engliſh magneſia. "That prepared directly from the bittern, is by no means equal in purity to that produced from Epſom ſalt."

Our workmen are confeſſedly unacquainted with the moſt eligible method of obtaining it in genuine purity; nor can they have accurate ideas upon the ſubject, unleſs they poſſeſs ſome knowledge of the laws of chymical affinity, and the powers of elective attraction. Incidents influenced by theſe principles, although perfectly familiar to the mind of every chymical operator, would be conſidered by thoſe not verſed in that ſcience, as inexplicable phenomena. Referring to chymical writers for further information, it will ſuffice for our purpoſe to obſerve, that an acid and alkali poſſeſs oppoſite principles, and that a combination of the two, form a neutral compound. Epſom ſalt is preciſely in this predicament, being

formed

formed by a combination of an abſorbent earth, or magneſia and thevitriolic acid. It is by the decompoſition of Epſom ſalt, or diſunion of theſe conſtituent parts, that we obtain genuine magneſia. There is a diverſity in the minutia of the proceſs even in the hands of chymical operators; but ſince Mr. Henry, of Mancheſter, (England) has improved upon the proceſs, and his magneſia having juſtly obtained celebrity and preference on account of its delicate whiteneſs and purity, his method ſhould be recommended as moſt eligible for our imitation. The followingisnot eſſentially varient from Mr. Henry's proceſs. "Take any quantity of Epſom ſalt, diſſolve it in boiling water, and filter the ſolution. Diſſolve alſo half the quantity of good pearl aſh, and filter the ſolution. Both of theſe ſolutions ought to be ſomewhat diluted, and it will be proper to uſe twice the quantity of water, which would fairly diſſolve the ſalts. Mix the two ſolutions when nearly cold, and ſtir them very well together. Let the mixture ſtand for ſome hours, until the precipitate has fallen to the bottom in form of a coarſe gritty powder. Put the whole then into a clean copper kettle, under which a moderate fire is made. Stir the matter inceſſantly with a large wooden ſpatula, to prevent the powder from ſticking to the bottom. As the mixture heats, the powder begins to looſe its ſandy appearance, and to increaſe greatly in quantity; ſo that though at firſt the mixture was quite thin, with only a ſmall portion of ſandy matter amongſt it, before it has attained the boiling heat, it will be ſo thick that it can ſcarcely be ſtirred. When the grittineſs is quite gone,

gone, the matter muſt be put upon a filtering cloth, and warm water poured upon it, till it runs inſipid. The magneſia is then to be put upon chalk ſtones, which will abſorb the greateſt part of the moiſture, and it may at laſt be fully dried in a ſtove."*

In preparing this medicine, no point in the proceſs is more important, than the repeated ablutions with ſoft pure water. The hardneſs of that from ſome wells and ſprings, renders it altogether improper for the purpoſe ; but ſoft river or rain water, after being filtrated through a thick linen cloth, will anſwer equally as well as diſtilled water, recommended by ſome operators. The ablutions, however, ſhould be repeated until the medicine be reduced to an impalpable powder, free from all grittineſs or other impurities. The chalk ſtones employed for the purpoſe of drying, ſhould be frequently cleaned and expoſed to a moderate degree of heat, and the powder encloſed in ſheets of white paper, and carefully dried before the fire or in a furnace.

Thus have I endeavoured to contribute my mite to the common intereſt ; and however deficient my claim to general applauſe, I can repoſe with confidence in the hope of *candor* from the patrons of the Arts and Sciences.

Such is the intereſting nature of this ſubject, that the propriety of a communication to the Academy of Arts and Sci-

ences

* See Encyclopedia, Motherby's Medical Dictionary, and Quincy's Diſpenſatory, 15th edition, Appendix.

ences has been suggested, and should it afford satisfaction to that learned and respectable Association, and in any measure aid the spirit of industry and enterprise in our country, I shall realize an ample reward.

I have the honor to subscribe myself, Gentlemen, with sentiments of profound respect, your most obedient

humble servant,

JAMES THACHER.

Plymouth, August 16th, 1802.

Process for making Cider, communicated in a letter from RICHARD PLATT, *Esq. to Hon.* JOHN ADAMS, *L.L.D. President of the Academy.*

ALL late kinds of apples are best, for instance, Hughes's Crab of Virginia, Redstreak, and other sound, hard fruit.

That the operation may be conducted to the best advantage, the following rules must be strictly adhered to.

1. Select all immature and rotten apples, and put the choicest under cover from rain, as gathered from time to time, but exposed to sun and air, as much as possible to mature, until the season is so far advanced that the weather becomes cool and dry; nights a little frosty, but not freezing hard.

hard. This will happen either at the latter end of October, or by the middle of November, and the later the better.

2. In grinding, a single tier of apples only is to be laid in the trough at once, to admit of equal pressure, and the wheel should not be heavy, as experience proves that bruising the apples for about six minutes (if thus arranged) is preferable to filling the trough, as is usual, and grinding them for a long while, till fine. According to this new mode, there is less juice from the first running, but abundantly richer, and the cheese being decompressed, and ground over, will give the residue for water cider.

3. The pumice must be put in hogsheads with one head out, or hogshead tubs, and there remain at least 36 hours, then made into cheese with much good clean long straw, and pressed as usual. When the juice is taken out of the receiving tub, it must be strained through fine, close, and thick flannel, wet in the first instance with water, and frequently rinsed out to admit the cider to pass through.

4. The juice, thus prepared, goes into the cellar, where it is to remain and undergo operation, as follows, viz.

The casks being filled up to the bungs, when the fermentation comes briskly on, pour into the hogshead or pipe, a pint of best Coniac brandy, and continue to do the like, to each, five successive times, at the space of about six hours asunder, when it will be found, that the liquor is sufficiently fermented, and the more certainly to accomplish it, there must be at

hand, in jugs or demijohns, (as moft eafy to pour out of,) fome new water cider, expreffed from the contents of the original cheefe, to pour in frequently, and fill up the cafks. To be fatisfactorily afcertained of due fermentation, a tap muft be placed in the centre of the head of each cafk and frequently pulled out. The eye and tafte being the criterions to guide; whenever the firft is delighted, and the fecond gratified, that is the moment for drawing off the cider, and *putting it in other cafks*, (well cleanfed and fweetened with Coniac brandy,) *which muft ftand perpendicular*, and have a pint of fweet oil poured on the top, thereby giving fcope to gravitation, and effectually excluding all air, owing to which the cider will always be fine, and retain its fweetnefs for any length of time. One may commence drawing from a cafk thus arranged, the day after the tranfpofition, and continue till fpring, when the refidue will be fit for bottling. Cafks fhould be made long and broadeft at top, in order to give the beft effect to the procefs, as in fuch cafe, there will be no danger of breaking the furface of the oil, which muft happen in hogfheads and pipes (unlefs a very large quantity is put on) owing to the expanfion of furface as the fluid defcends.

Superiorities of this procefs.

1ft. Pureft juice.

2d. Moft perfect fermentation, fortified by the choice brandy.

3d. Fulleft fcope to gravitation.

4th. Total exclufion of air.

Flufhing, Long Ifland, October 21, 1803.

Account

Account of the resuscitation of a Mouse, found in a torpid state, enclosed in a fossil substance. Communicated in a letter from OLIVER FISKE, *M.D. to Hon.* ROBERT T. PAINE, *A.A.F.*

Worcester, March 15, 1803.

SIR,

ENCLOSED you will receive an authenticated statement of the facts respecting the resuscitation of a mouse, which some time since was the subject of a communication to the American Academy of Arts and Sciences.

The testimony of Mr. Lincoln I could not obtain, as he now resides in some part of Vermont. Mrs. Andrews, and others of the family, can affirm all that is stated as having taken place in the house. Being personally acquainted with Mr. Andrews, who is one of our most respectable farmers, and a very correct man, I have not the least hesitation in subscribing my belief that the enclosed statement is correct.

I am, Sir, most respectfully, yours,

OLIVER FISKE.

Hon. ROBERT T. PAINE, *Esq.*

P. S. It may perhaps be inquired, why a matter so extraordinary was not sooner made public? It did not occur to Mr. Andrews, that a subject like this would be thought worthy of any particular notice. It was talked of among his neighbours, and almost forgotten. In October last, I had the

first

firſt intimation of it; and judging the fact to be important, as connected with the inveſtigation of natural hiſtory, I applied to Mr. Andrews for the purpoſe of preſerving it, and received from him the narration as encloſed. Being appriſed of the uſe I intended to make of it, Mr. Andrews appeared cautious not to ſtate any thing, which he could not clearly recollect.

O. F.

In the month of November, A. D. 1798, being at work with my hired man, *Luke Lincoln*, in removing ſome loamy ſand from a ridge, which projected into a meadow, we diſcovered a ſubſtance of about the ſize of a gooſe egg, which from its colour and conſiſtence, we at firſt ſuppoſed to be a piece of iron ore; being as hard as dried mortar, or a lump of clay expoſed to the ſun. After ſeveral attempts, with the corner of a ſpade, we broke it, and to our ſurpriſe, found its *nucleus* was a *mouſe*, rounded into a compact form, which, upon being removed from the ſhell, left a vacancy of the ſame dimenſions as its ſize.

Recollecting to have heard of the reſuſcitation of *toads*, dug from the earth in a ſimilar ſituation, and with a view of making a ſimilar experiment, I carried the mouſe, to all appearance dead, into the houſe, and placed it at a proper diſtance from the fire to obtain a gradual warmth. Some ſymptoms of returning life began ſoon to appear; after a little ſtruggling, in a few minutes it was reſtored to a perfect, living ſtate, and ran off with activity.

The

The mouse was of the species, called by the Count de Buffon, the *long tailed field mouse*, or with us, from its shape, colour and activity, the *deer mouse.*

There was no appearance that the ground ever had been broken up, nor was there any communication from this substance with the external air, or surrounding earth. In short, we saw no reason to doubt that the mouse had been immured for a century.

DAVID ANDREWS.

Signed in presence of
OLIVER FISKE.

Worcester, March 3d, 1803.

Account of an Inscribed Rock, at Dighton, in the Commonwealth of Massachusetts, accompanied with a copy of the Inscription. By JAMES WINTHROP, *Esq.*

IN Taunton river, about six miles below the town of Taunton, and within the limits of Dighton, is a rock containing an hieroglyphical inscription, which has long engaged the attention of the curious. The rock is on the eastern side of the river, upon the beach, and the inscribed side fronts about northwesterly. At the lowest tides the water retires from the foot of it, but at high water it is commonly covered. The longest side contains the inscription, and looks toward the channel of the river, and is the natural face of the rock, not smoothed

ſmoothed by art. It is on this ſide ten feet ſix inches long, and four feet two inches wide. The height is not ſo great, for the plane declines about thirty degrees from the perpendicular, ſo that the top of the rock is about two feet from a perſon ſtanding by the baſe of the inſcribed ſide. The other ſides are ſhorter, and drawn to a point toward the ſhore, and are rough, as if large pieces had been broken off. The rock is of a dull reddiſh colour, which is common with the ſtones in that neighbourhood. Tradition informs us, that in the laſt century it ſtood as much as four rods from the river, but the inhabitants by digging round it, upon the fooliſh expectation of finding money, gave a paſſage to the tide.

It is agreed, on all hands, that the inſcription is hieroglyphical; but for want of a perfect copy of it no ſatisfactory explanation has been given. A very imperfect copy was publiſhed early in this century in the philoſophical tranſactions of the Royal Society of London. About twenty years ago a much more complete one was taken by the learned Profeſſor Sewall, and is depoſited in the Muſeum of the Univerſity in Cambridge. The lower part of the rock has been for a long time coated with moſs and dirt, which concealed a conſiderable part of the inſcription, and the ſhortneſs of the time, which the tide leaves it, makes it impoſſible, in the common method of copying, to be perfectly exact. This will abundantly account for any deficiency or imperfection in the copy taken by Profeſſor Sewall, whoſe habitual accuracy and attention are well known.

In

In the courſe of laſt Auguſt, upon the invitation of Judge Baylies, of Dighton, I went to view the rock, and take a copy of it. We were aſſiſted by Rev. Mr. Weſt, and Col. Edward Pope, both of New Bedford, and Rev. Mr. Smith, of Dighton. We ſpent one day in cleaning the face of the rock, tracing the character, and painting it black, beginning to work when the tide had fallen, ſo as not to be above our knees, and finiſhed this operation when the water was about as deep, upon the flood. The next day, which was the fourteenth of Auguſt, the ſame company went to the rock, provided with a large ſheet of paper, of the whole ſize of the inſcription, and after retracing the character with paint, to cure any viſcidity which the firſt paint might have contracted from the extreme heat of the weather, we applied the paper to the face of the rock, two of us managing the ends of the ſheet, and the remainder, with towels, which we dipt into the river, preſſing the paper upon the rock. This made the paper conform to the ſurface, and the paint preſently began to appear through it. As ſoon as the paper was dry enough to be removed, we laid it upon the ſhore and completed the character with ink. Afterward I brought it home, and hanging it up to the light, traced the inſcription with ink upon the other ſide of the paper, it having been reverſed by the manner of copying from the rock. Having thus completed the copy, I had a large pentagraph made, which would expand thirteen feet, and by this means

have

Inscription on a rock in Taunton river.

have made a fair draft, which I requeſt the Academy to accept.*

The inſcription comes within eight inches of the bottom of the rock, and runs off at the top and ends, which makes it highly probable, that it has ſuffered conſiderably ſince it was firſt wrought. The character is generally about half an inch wide and very ſhallow, appearing as if it were made by ſome pointed inſtrument. In the copy I have marked it by parallel lines, and their diſtance ſhows the width of it upon the rock. The ſingle circles repreſent dots, and where there are two concentric circles, they repreſent a ring or circle in the original work.

I have been more particular in deſcribing the proceſs of taking the copy, becauſe I believe it to be the firſt time in which it has been adopted, and appears in practice to be ſimple and exact.

Cambridge, Nov. 10, 1788.

MEDICAL

* Plate III, exhibits a reduced repreſentation of Mr. Winthrop's original draft; accurately traced under his inſpection.

MEDICAL PAPERS.

An Account of the Diſſection of three Perſons who died of the Malignant Epidemic that prevailed in Boſton, in the Summer of 1798. *By* ISAAC RAND *and* JOHN WARREN, *M.D. F.A.A.*

Boſton, September 8, 1798.

THE great advantage to be derived to mankind from an inſpection of the bodies of ſuch as have died of ſo formidable an epidemic as the yellow fever, muſt be obvious to all. The following caſes of diſſection may throw ſome light on the nature of the diſeaſe as it prevails in this town, and may, we hope, be of ſome uſe in inveſtigating the treatment beſt adapted to the purpoſe of checking or ſuppreſſing its deſtructive ravages.

The firſt caſe was of a man, who died on the ſixth day from the ſeizure, and as no application was made to a phyſician till the firſt ſtage of the diſeaſe had nearly expired, the ſtate of the organs may be conſidered in a great meaſure as the natural effect of the diſeaſe, undiſturbed by art.

In the cavity of the cheſt, the lungs were remarkably affected; they contained an uncommon quantity of dark blood in their veſſels, which rendered them apparently more denſe than

 uſual;

ufual ; the vefícles not being diftended with air, and their fubftance confequently lefs compreffible than ufual. The pofterior part of both lobes was extremely livid, and in the cavities of the thorax was contained a large portion of extravafated blood, firmly coagulated, to the quantity of eight or ten ounces, as nearly as could be eftimated.

The pericardium contained as much as two or three ounces of fluid blood. The heart was of its ufual fize ; but the coronary veins were fo diftended with blood, as to exhibit the appearance of a moft fuccefsful injection. In the cavity of the abdomen, the part moft confpicuoufly morbid was the liver. This organ appeared to be much inflamed both on its convex and concave furface ; its fubftance was much indurated, and, on cutting, refembled in colour, a boiled liver. The gall bladder was contracted to a very fmall fize, and contained not more than a quarter of an ounce of a thick, glutinous, and almoft infpiffated fubftance, refembling pitch. There were no marks of any confiderable quantity of the bile having been lately contained in the fack, and none of the neighbouring parts had the leaft tinge that denoted its prefence. On cutting through the ductus communis choledochus, no bile iffued from the aperture ; the hepatic duct had alfo evidently for fome time ceafed to tranfmit its fluid from the liver. The ftomach exhibited an enormous diftenfion of its veins, efpecially round the pylorus, and had every mark of great inflammation. The inteftines, in general, were in the fame ftate with the ftomach ; the fmaller were confiderably diftended, and the larger contracted.

tracted. The fpleen was uncommonly turgid, but in other refpects in its natural ftate. The peritonæum on the under fide of the diaphragm, and the pleura on the upper, bore the veftiges of inflammation, but no other parts of thofe membranes appeared to have been difeafed.

The omentum was confiderably thickened, and from the turgefcence of its blood veffels, of a colour unufually dark. There were no appearances in the thoracic or abdominal vifcera, of fuppuration, nor was any degree of fetor perceived to arife from them; nor was there the leaft mark of incipient putrefaction in any part of the body. It may be proper to remark on this cafe, that in every ftage of the difeafe, the difcharges from the bowels were of the colour and confiftence of water gruel, excepting a few evacuations of a matter fimilar to what is called the black vomit; and that this ufually fatal fymptom had alfo preceded the patient's death on the fourth day of the difeafe.

The fecond cafe. The fubject of this diffection was the body of a perfon who died on the 12th day from the attack, with fymptoms of the mixed kind; a remiffion of the difeafe had taken place, at the period ufually critical, upon which, on the fixth day, a delirium enfued, and continued to the moment of fatal termination.

On opening the cranium, the brain was found to have its veffels aftonifhingly diftended with blood, an ounce or two of ferum was effufed between the dura and pia mater. Under

the ſagittal ſuture, and by the ſides of the longitudinal ſinus, where the large veins terminate in that cavity, a lymphatic band, about an inch wide, extending nearly the whole length of the ſinus, was formed by the coagulable lymph, which had been effuſed from the blood veſſels, by the violence of the preceding inflammation, and this ſubſtance had ſerved as a medium of adheſion, between the dura and pia mater in that part.

The lungs adhered very firmly to the pleura on the right ſide, and appeared poſteriorly to have been much inflamed, and in ſome parts to be indurated in portions of about the ſize of a pigeon's egg. The left lobe adhered ſo firmly to the pleura, as not to be ſeparated but by tearing the ſubſtance of the lungs which here appeared extremely diſeaſed, and in a ſtate of actual ſuppuration throughout its whole ſubſtance. The heart was in its natural ſtate. The liver was much enlarged, and in a ſtate that denoted a high degree of inflammation ; the convex ſurface of the great lobe near the gall bladder exhibiting marks of extravaſation, as if violently contuſed. The gall bladder was full of bile, and the ducts pervious.

The ſtomach was nearly in its natural ſtate ; but, on the inſide, the ſurface of the villous coat was beſmeared with a matter which ſeemed to be of the ſame nature with the black vomit, though nothing of this kind had been ejected in the courſe of the diſeaſe.

The duodenum was much inflamed for ſeveral inches from its commencement at the ſtomach, and the whole tract of the

ſmaller

ſmaller inteſtines was in the ſame ſtate. The urinary bladder was contracted to the ſize of a pullet's egg, and its inner coat appeared to have been in a high ſtate of inflammation, the veſſels having been diſtended to ſuch a degree as to have ſuffered a rupture, and to have effuſed a quantity of blood into the cavity of this organ.

The ſtate of the lungs in this ſubject was probably the conſequence chiefly of a previous diſeaſe, independent of that which proved fatal. An affection of the lungs had ſome time exiſted, whilſt the ſubject was, in other reſpects, in tolerable health, and in the purſuit of his buſineſs; ſo that a pulmonary conſumption would, in all probability, have ſhortly put a period to his life, had the diſeaſe of which he died never overtaken him.

The third caſe. In this inſtance the diſeaſe terminated fatally on the fourth day.

Upon opening the thorax, the lungs diſcovered marks of inflammation, anteriorly, and were extremely gorged with blood, in the poſterior part of their reſpective lobes.

The liver exhibited marks of inflammation, eſpecially on its concave ſide and poſterior part; its texture was altered, and of a very denſe conſiſtence. The gall bladder was completely obliterated, its coats having coaleſced with the contiguous parts, ſo as to form with them one confuſed membranous ſubſtance. The ſtomach was externally, to appearance, in a natural ſtate, but its inner coat was covered with that black coloured fluid, denominated the black vomit.

The

The colon in ſome parts had been much inflamed, as well as part of the omentum, which was attached to this inteſtine.

It is worthy of remark, that in both the caſes where the gall bladder had been diſeaſed, and ceaſed to perform its functions, or if the liver had been rendered incapable of ſecreting the bile, the body became yellow before death; whereas, in the other, where the bile was found in due quantity, this circumſtance did not occur.

From the above diſſections, which evinced a deficiency of ſecretion in the biliary organs, the indications of cure ſeemed to be directed towards a courſe, which might obviate the inflammation in general of the organs diſeaſed, and open the excretory ducts of the liver, that the fluid might reſume its courſe into the inteſtines.

It is with the higheſt degree of pleaſure that we communicate to the public our hopes, that after proper evacuations, the uſe of calomel may be found to anſwer theſe important purpoſes. This medicine has been accordingly uſed with much ſucceſs in fifteen patients, within eighteen days, all of whom, excepting one, have recovered, or have paſt the dangerous period. It has been given not in the uſual doſes, for the purpoſe of an evacuant by the inteſtines, but in ſmall doſes of one, two, or three grains, every hour or two, ſo as to produce a ſalivation as ſoon as poſſible; with this view, from one hundred to two hundred and thirty grains of calomel have been given in the courſe of three or four days, commencing the uſe of it imme-

diately

diately after the firft copious evacuations by bleeding and purging; and, in every inftance, as the falivation came on, the difeafe abated.

Coinciding in fentiment refpecting the ufe of mercury, fo as to produce a falivation, we with pleafure mention the learned Dr. Rufh of Philadelphia. But the method is more explicitly and highly recommended by James Clark, M.D. F.R.S.E. in a treatife on the yellow fever, as it appeared in the ifland of Dominica, in the years 1790, 94, 95, and 96.

The Doctor recommends the free ufe of mercury, both as a remedy and preventative; and fays, "the officers of the army and navy, who have leifure and can be prevailed upon, on their arrival in the Weft Indies, to undergo one or two courfes of mercury, take a few laxative medicines, after confining themfelves to a moderate ufe of wine, and living chiefly on vegetables and fruits for the firft two months after their arrival, may rely, almoft to a certainty, on efcaping the fever.

ISAAC RAND.
JOHN WARREN.

On

On the Uſe of Oil of Tobacco in the Cure of Cancers; in a letter from Rev. ZEPHANIAH WILLIS, *of Kingſton, to Rev.* JOSEPH WILLARD, *D.D. L.L.D. F.A.A.*

Kingſton, January 13*th*, 1786.

REV. SIR,

AS every diſcovery tending to the cure of cancers may be of importance, eſpecially to thoſe who have the misfortune to be viſited with this dreadful diſeaſe, the following cure may poſſibly be deemed worthy of notice.

Jonathan Holmes, of this town, is aged 77, deſcended from a family which has been remarkably ſubject to cancers. About 25 years ſince, an eruption appeared near the outer corner of his left eye, which continued to increaſe till it appeared to be a confirmed cancer. He made application to a French ſurgeon then in the country, who profeſſed ſkill in ſuch caſes, and had it taken out; and after ſubmitting to a long and ſevere courſe of phyſic, appeared to have obtained a perfect cure.

About five years ſince, a ſimilar eruption appeared under his right eye; it continued to increaſe ſlowly, attended with the uſual ſymptoms of a cancer, for about four years. During this period, he applied to a ſurgeon to have it extracted; but being near the eye, he refuſed to operate, leſt it ſhould deſtroy his eye and haſten his diſſolution. After this, it increaſed very faſt, diſcharging a virulent humour, and having conſider-

ably large excreſcences, denoting it to be a cancer of the roſe kind.

That fondneſs for life which is natural to all, and the dread of falling a ſacrifice by this moſt terrible of all executioners, together with ſome hints received upon the ſubject, prompted him to try the following experiment. Being himſelf a ſmoker of tobacco, he practiced filling his pipe with ſtrong tobacco and ſmoking it part out, applied a thin linen rag over the top of the bowl, and putting it to his mouth, blew the ſmoke through the ſtem ; by which a ſmall quantity of oil was expelled with the ſmoke. By repeatedly blowing, a conſiderable number of drops of this oil were eaſily collected, which he applied to the cancer, both with his finger and by wetting lint with it and laying it on. This oil being of a very pungent nature, cauſed a very ſtrong ſenſation. But a very few applications produced an evident alteration for the better. He continued the application morning and evening, and at other convenient ſeaſons, attended with ſimilar effects, for ſix weeks or two months ; at the expiration of which, the cancer was entirely healed, with a very little ſcar remaining.

In the firſt experiment which he made to extract the oil, which was with a new pipe, he found that the oil was almoſt wholly abſorbed by the ſtem. To prevent this, breaking off the ſtem, he joined a wooden one, perforated in the ſame manner : this he found did not abſorb the oil, and that with a very little trouble a ſufficient quantity was obtained.

Whether this ſimple caſe be worth communicating, is humbly ſubmitted by your

moſt obedient,

reſpectful ſervant,

ZEPHANIAH WILLIS.

The Rev. Joseph Willard, D.D.

APPENDIX.

APPENDIX.

COUNT RUMFORD'S DONATION.

SIR,

DESIROUS of contributing efficaciouſly to the advancement of a branch of ſcience, which has long employed my attention, and which appears to me to be of the higheſt importance to mankind; and wiſhing at the ſame time to leave a laſting teſtimony of my reſpect for the American Academy of Arts and Sciences, I take the liberty to requeſt that the Academy would do me the honor to accept of five thouſand dollars, three per cent ſtock, in the funds of the United States of North America, which ſtock I have actually purchaſed, and which I beg leave to transfer to the Fellows of the Academy, to the end that the intereſt of the ſame may be by them, and by their ſucceſſors, received from time to time, for ever, and the amount of the ſame applied and given, once every ſecond year, as a premium to the author of the moſt important diſcovery, or uſeful improvement, which ſhall be made and publiſhed by printing, or in any way made known to the public, in any part of the continent of America, or in any of the American iſlands, during the preceding two years, on heat, or on light, the preference always being given

to

to ſuch diſcoveries as ſhall, in the opinion of the Academy, tend moſt to promote the good of mankind.

With regard to the formalities to be obſerved by the Academy in their deciſions upon the comparative merits of thoſe diſcoveries, which, in the opinion of the Academy, may entitle their authors to be considered as competitors for this biennial premium, the Academy will be pleaſed to adopt ſuch regulations, as they in their wiſdom may judge to be proper and neceſſary. But in regard to the form in which this premium is conferred, I take the liberty to requeſt that it may always be given in two medals, ſtruck in the ſame dye, the one of gold, and the other of ſilver, and of ſuch dimenſions, that both of them together may be juſt equal in intrinſic value, to the amount of the intereſt of the aforeſaid five thouſand dollars ſtock, during two years ; that is to ſay, that they may together be of the value of three hundred dollars.

The Academy will be pleaſed to order ſuch device or inſcription to be engraved on the dye they ſhall cauſe to be prepared for ſtriking theſe medals, as they may judge proper.

If during any term of two years, reckoning from the laſt adjudication, or from the laſt period for the adjudication of this premium by the Academy, no new diſcovery or improvement ſhould be made, in any part of America, relative to either of the ſubjects in queſtion, (heat, or light,) which in the opinion of the Academy, ſhall be of ſufficient importance to deſerve this premium ; in that caſe, it is my deſire that the premium

may

may not be given, but that the value of it may be reſerved, and being laid out in the purchaſe of additional ſtock in the American funds, may be employed to augment the capital of this premium ; and that the intereſt of the ſums by which the capital may from time to time be ſo augmented, may regularly be given in money, with the two medals, and as an addition to the original premium, at each succeeding adjudication of it. And it is further my particular requeſt, that thoſe additions to the value of the premium ariſing from its occaſional non-adjudications may be ſuffered to increaſe without limitation.

With the higheſt reſpect for the American Academy of Arts and Sciences, and the moſt earneſt wiſhes for their ſucceſs in their labours for the good of mankind,

I have the honor to be, with much eſteem and regard,

Sir,

Your moſt obedient,

humble ſervant,

RUMFORD.

London, July 12th, 1796.

To the Hon. JOHN ADAMS, *Eſq. Preſident of the American Academy of Arts and Sciences.*

Vote

Vote of Thanks to Count RUMFORD.

AT a meeting of the American Academy of Arts and Sciences, at Boſton, May 29, 1798.

Whereas Benjamin Count of Rumford of Munich, in Bavaria, has preſented to this Inſtitution, the ſum of five thouſand dollars in the three per cent ſtock of the United States, the intereſt of which, by the terms of the donation, as expreſſed in his letter of July 26, 1796, to the preſident of the Academy, is to be " applied and given once every ſecond year, as a premium to the author of the moſt important diſcovery or improvement which ſhall be made and publiſhed by printing, or in any way made known to the public, in any part of the continent of America, or in any of the American Iſlands, during the preceding two years, on *Heat*, or on *Light* :" which donation has been accepted by the Academy, and by proper certificates, which accident only has delayed,* the ſaid ſtock has now become the property of the Academy.

Voted, That the thanks of the Academy be preſented to Count Rumford, for this his very generous donation, and that they experience the higheſt ſatisfaction in receiving this additional and very liberal aid for the encouragement and extenſion of thoſe intereſting branches of ſcience, which he has ſpecified as the objects of his gratuity, and which *he* has ſo

ſucceſsfully

* The certificates of ſtock, and the power of attorney to make the transfer, were loſt, in conſequence of the capture of the veſſel by which they were ſent.

fuccefsfully cultivated : That they entertain a high fenfe of the fentiments and views, fo becoming a philofopher, which have prompted him to this diftinguifhed act of liberality ; and in the execution of the grateful office, which they have undertaken, of awarding and diftributing the premium which Count Rumford has thus appropriated, they will facredly comply with the conditions of the donation ; indulging the hope, that he will meet his reward, in learning that many in his native country are thereby excited to emulate his labours, and to promote the accomplifhment of his beneficent wifhes for the advancement of fcience, and the augmentation of human happinefs.

Voted, That the Correfponding Secretary be requefted to tranfmit a copy of the preceding vote to Count Rumford by the earlieft opportunity.

AT a meeting of the American Academy of Arts and Sciences, May 26, 1801.

Voted, That the Academy at their meeting in May next and afterwards, biennially, at their May meeting, will decide on the difcovery or improvement, which may appear to be entitled to the premium directed to be given by Count Rumford, according to the terms of his letter to the prefident of the Academy, dated July 12th, 1796.

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